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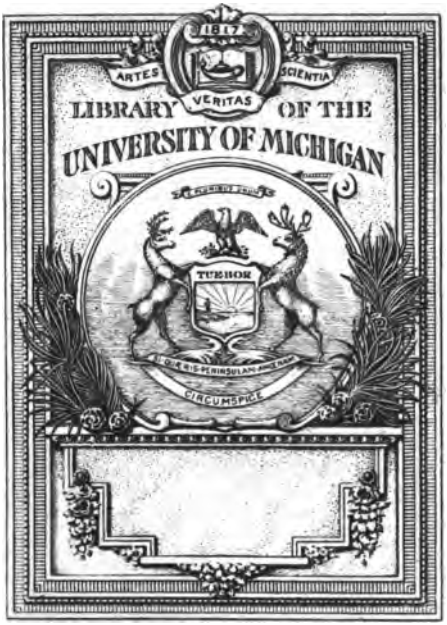
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THE

# REPERTORY

OF

# ARTS, MANUFACTURES,

AND

# AGRICULTURE.

No. XCI. SECOND SERIES. Dec. 1809.

*Specification of the Patent granted to* WILLIAM FRANCIS HAMILTON, *of Lower Mount-street, in the City of Dublin; for a new Method of preparing Soda, and other mineral Waters; spirituous, acetous, saccharine, and aromatic Liqueres; and sundry Improvements relative thereto.* Dated May 4, 1809.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said William Francis Hamilton do hereby declare that the nature of my said invention is described in manner following; that is to say:

I use various solutions of alkalies, salts, &c. and combinations of ardent spirit, vegetable acids, aromatic oils, sugar, milk, mucilage, &c. for saturation and supersaturation, with carbonic acid.

I obtain my gas from the decomposition of whiting, with dilute sulphuric acid; applying the whiting in a

liquid state, to admit of its introduction to the laboratory, in which the carbonic acid is disengaged with facility and cleanliness. The gypseous residuum I let off also liquid.

I expose the solution, &c. in a strong, well tinned copper vessel, under more or less pressure, for the absorption of fixed air; which may be effected (by its suffering considerable agitation in a cold bath, suspended by pendulous tubes), without interruption to the injection of solution, &c. from a condensing syringe, or discharge of aerated liquor, from a decanting stop cock, so that the bottling can exist continually.

I use a piston, solid and cylindrical; fitted with a thin collar of leather, at the lower extremity of the pump. It forces upwards, causing the proportionate supply of liquid matter which is injected by it at the same time with the carbonic acid, to serve as a lute to the collar of leather, already nearly air-tight. This principle of liquid luting, I apply in every possible instance.

The valves I sometimes place in the plugs of the acting stop-cocks, so that if they get out of order they can be easily ground air-tight again, by withdrawing the plugs; in which case the charge may still be preserved in the vessel by means of another set of stop-cocks placed nearer to it, and used only on such occasions, or when it is necessary to anoint the acting ones with a composition of oleaginous wax, tallow, &c.

I generally use a glass or earthen bottle, or jar of a long ovate form, for several reasons, viz. not having a square bottom to stand upon, it can only lie on its side; of course no leakage of air can take place, the liquid matter being always in contact with the stopper. It permits

permits its contents to be poured out more easily, and consequently with less loss of fixed air. It can be much stronger than a bottle or jar of equal weight, made in the usual form, and is therefore better adapted for packing, carriage, &c. The neck and mouth of the bottle are sometimes so formed, that it may serve as a drinking glass, if necessary.

I commonly stop with cork; which from the excessive pressure generally existing within the bottle, flies out on the detaining strings being cut, but sometimes I use glass or earthen stoppers, fitted conically in the usual way, or ground in across the neck. I also occasionally use stoppers of various ligneous matter, closing the pores with coatings of insoluble compounds.

I generally saturate under a pressure of 120 square inch; which is somewhat reduced on the liquors being bottled. The decantation is effected by stopping the mouth of the bottle or jar with a perforated flat cork, leather, &c. through which passes the decanting tube; so that, on opening the cock, the aerated liquor rushes into the bottle or jar till resisted by the condensation of the atmospheric air it originally contained, and a portion of carbonic acid gas extricated during the effort. The decantation is continued, by suffering the condensed air to escape. When full, the bottle or jar may be withdrawn and stopped with ease, by letting off slowly, a small portion of the fixed air contained before its removal: sometimes I construct the decanting cock so as to allow the stopper to pass into the bottle or jar previous to its removal from the flat air-tight fitting; by which means the entire pressure, how great soever, may be altogether retained.

In witness whereof, &c.

*Specification of the Patent granted to* THOMAS MEAD, *of Scott-street, in the Parish of Sculcoates, in the County of York, Engineer; for a Method or Methods of making and constructing circular or rotative Steam-Engines upon an entire new Principle, and employing the elastic or expansive Force of Steam in a much more efficacious and advantageous Manner than has hitherto been done.*

Dated August 24, 1808.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that the said Thomas Mead, in compliance and performance of the condition of the said letters patent, doth, by this instrument in writing, under his hand and seal, particularly describe and ascertain the nature of his said invention, and the manner in which the same is to be performed, as well by a description in writing, as also by delineations of apparatus that will help to illustrate or exemplify his principles; that is to say: The principle of the invention is not confined to engines of any particular form of construction, but consists in making use of two moveable pistons or diaphragms in such a manner, that they alternately revolve or move round their axes or centres, as will be more fully explained in what follows. A and B (Plate I, fig. 1), two circular plates or shells of metal, similar in their construction, having their insides turned, or otherwise made very true and correct; A is drawn with its inside uppermost, and B with its outside uppermost. Each of these circular plates or shells have a flanch and semicircular cavity formed for the reception of the pistons which are afterwards described, and a recess or hollow part formed round its centre for a small circular plate to turn in.

Near

Near to the edge of each recess is a small groove running quite round it; in the bottom of each groove is placed a metallic ring N, the remaining part of the groove is filled up with packing or wadding, which ring and packing or wadding may be moved by screws going through each shell (see *oooo* in the section and shell B), and may be turned on the outside of the engine after it is put together at any time, to make the small circular plates work steam-tight. On the outside of each shell at its centre is a hollow pipe or boss for the reception of the spindles F and G. The plate A has also two holes at *a a*, to which pipes are fitted, one to convey steam into the shells, the other to conduct it from them into a condenser, or wherever it may be required. C C two pistons with grooves round them to admit of a packing or wadding. D and E two small circular plates to which the pistons are connected or made fast. F and G two shafts or spindles; the spindle F is made hollow to receive the spindle G, which passes through it. H and I two arms made fast to the two spindles; each arm, near its extremity, carries a wheel J and K, which are generally termed friction wheels. L a fly or regulating wheel fixed to one end of a shaft or moveable axis, having in its front or side opposite to its axis a groove running across its diameter for the reception of the friction wheels J and K, which wheels, when the pistons are put in motion, work in it, and give motion to the fly wheel and other machinery which may be connected with it. M is a section of the two plates or shells A and B when put together, to shew more clearly the form into which they are turned or made. P P the steam chamber for the reception of the steam and pistons. Q the recess for the small circular plates. R R the hollow pipes or bosses

for

for the spindles to work in. S S S S flanches by which the shells are fastened together. T a front view of one of the pistons with its small circular plate, arm and friction wheels; J the friction wheel; H the arm; D small circular plate, and C the piston. V V V grooves for the reception of the packing or wadding, which is to be made fast therein. When the engine is to be put together the arms should be taken off from the spindles; the spindle G is then to be inserted in the hollow spindle F, which with their respective pistons and small circular plates are to be placed in one of the shells, and the other shell placed over them; the shells are then to be fastened together with screws or otherwise, so as just to admit the pistons with their respective plates and spindles to turn round in their respective chambers or channels nearly steam-tight; the arms may then be made fast on the spindles, and the engine erected. When the engine is to be erected or fixed for working, the following rules should be observed: place the direction of its axis in an horizontal or lateral direction, parallel with the direction of the axis of the fly, but nearly as much out of that line as the length of one of the arms H and I taken from the centre of the spindle to the centre of its friction wheel, and at such a distance from the fly as to admit of the friction wheels moving freely in the groove on its face. By so doing the axis of the engine will be placed eccentric with the axis of the fly. The engine may be fixed in an iron or wood frame, and the fly supported in the same or a separate frame, in the position before pointed out. If the fly is then turned half way round upon its axis, one of the friction wheels will remain locked or held fast in the groove near its centre, and the piston with which it is connected remain nearly stationary in the steam chamber between the holes *a a*, while the

the other friction wheel, with its arm, spindle, small circular plate and piston, make nearly one complete revolution round their common centre of motion, or the centre of the engine. If the motion of the fly continue till it has made one complete revolution round its own axis, the friction wheel which was locked or held fast in the groove near its centre, will move off in the groove towards the circumference of the fly, and with its arm, spindle, small circular plate and piston, make nearly one complete revolution round their common centre of motion, or the centre of the engine, and the other friction wheel in its turn remain locked, or held fast in the groove near the centre of the fly, and the piston with which it is connected remain nearly stationary within the steam chamber, between the holes *a a;* and so on alternately as long as the fly continues in motion. Instead of the hollow spindle F and the solid spindle G, two other solid spindles may be used by applying one to each small circular plate, and passing them through the opposite pipes or bosses, each having its arm and friction wheel as before, but working in separate grooves mounted on separate axles, and united by wheel work. When the engine is to be set to work by the force of steam, the steam is permitted to enter by one of the pipes into the steam chamber, where, by its elasticity, it will press or act upon both pistons nearly alike; and as one of the pistons is stopped or held fast by the aforesaid methods, the steam cannot pass into the other pipe that way, but will force the other piston round with its small circular plate, spindle, arm and friction wheel, and put the fly in motion, and continue it as before explained. A similar effect may be produced with a concave globe or sphere having within

it

it two moveable semicircular leaves (as a substitute for the pistons) with packings at their edges, and united in the centre or axis of the globe with joints or hinges, and having each of them an axis passing through the globe to receive the arms and friction wheels as before described, and with holes and pipes for the admission of steam, &c. A great variety of other forms may be made use of to produce a similar effect, as will be obvious to every collectable mechanic if the principle on which the engine acts be retained. Engines on this principle may be made of every requisite size, and are not confined to the action of steam only, but may be put in motion with a current of air, or any other elastic fluid, or a current of water, or a current of any fluid, either elastic or unelastic, if the fly wheels, or whatever may be substituted for them, be made to drive the pistons by being turned upon their axles with a sufficient force. They may be applied as powerful engines for extinguishing fire, or for raising or forcing water up to any height required, and may also be used as air pumps for philosophical experiments, or for air pumps and condensers for steam engines, and for many other useful purposes.

In witness whereof, &c.

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OBSERVATIONS BY THE PATENTEE.

In addition to the above exemplification, we beg leave through the medium of your valuable publication, to observe, that having now built and established at Hull, a large manufactory, under the firm of Mead, Penrose, and Co., hope we shall now be enabled to manufacture our patent engines for every purpose for which they may be

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be wanted, in a much more expeditious manner than we have hitherto been able to do, and to accommodate the public with engines of a far less complex construction on more reasonable terms, and superior in performance to any that have yet been erected, and at least equal to any that may.

---

*Specification of the Patent granted to* RICHARD TREVETHICK, *of Rotherhithe, in the County of Surrey, Engineer, and* ROBERT DICKINSON, *of Great Queen-street, in the County of Middlesex, Esquire; for a new Method or Way of stowing Cargoes of Ships and other Vessels by Means of Packages for containing Goods and Products of certain Descriptions destined for Conveyance by Sea, not hitherto employed.*

Dated October 31, 1808.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, we the said Richard Trevethick and Robert Dickinson do hereby declare that the nature of our said invention, and the manner in which the same is to be performed, are particularly described and ascertained as follow; that is to say: Instead of the packages, cases, chests, trunks, casks, vessels, or other receptacles heretofore and commonly used for the purpose of containing, enveloping, preserving and securing from damage, the several articles of merchandize and other goods, whether in the solid and consistent or in the liquid form, which are taken and stowed on-board ships and other vessels to be transported or consumed, or otherwise used and applied, we do construct, make, use, and apply certain

other packages, vessels, or receptacles, of iron, made by casting the said metal, or by forging, laminating, and rivetting together plates or portions of the said metal, with covers adapted to, and capable of being secured by, screws, bolts, or other known means, to the said vessels or receptacles, so as to render the same (when shut) close, secure, and impenetrable to the external air or moisture, or other hurtful matters and things.

And farther, we do make our said packages, vessels, or receptacles of such figures or forms that they fit exteriorly to each other without that waste of space which takes place in the stowage of wooden casks. For this purpose different forms may be used, but we prefer rectangular or hexagonal prism forms to all others. Where the same economy of room is not requisite, we employ the cylindric form; but whichever form be employed, a much larger quantity of goods can be stowed by means of our invention than can be stowed in an equal space when the goods are put into packages made of wood, the sides and ends of which are necessarily of a great thickness compared with those made of iron.

Nor is saving of room the only advantage which results from our aforesaid invention. Water, oil, and various other fluids, as well as provisions of different kinds, will be better preserved from waste, putrescency, leakage, depredations from insects and other living creatures in iron vessels, than in vessels made of wood. For some purposes we have our said iron packages, vessels, and other receptacles, tinned on the inside, or coated with a varnish, suited to the commodities they are destined to contain.

By our said invention great advantages as to space and comfort will be afforded to those on-board ships, without

without any detriment, but rather with advantage to the proper trim of carrying sail, and the safe and expeditious performance of their respective voyages.

In witness whereof, &c.

---

## *Description of an improved Telegraph.*

*By Major* CHARLES LE HARDY, *of the Island of Jersey.*

With a Plate.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

*The Silver Medal of the Society was voted to Major* LE HARDY *for this Communication.*

THE telegraph, of modern invention, is an improvement on communication by signals, which has been in use for many ages. Monsieur Chappe was, I believe, the first who proposed a machine for that purpose, which was put in execution about the year 1793. Since that time several modes have been proposed by different persons, none of which seem to have fully attained the object. A machine of this kind should be simple and easy to comprehend. All those which have come to my knowledge are executed by combinations, which render them too complicated for common use, and therefore liable to many errors. That which I now submit to your consideration seems to me to have removed every objection of the kind; it is simple, easy to comprehend, and extensive in its means; its combinations, which by simple numeration may be carried to 40,000, might with ease be extended to almost infinite numbers; but the present seems sufficient to answer every purpose. All the words in Entick's Dictionary amount to about 25,000;

every one of which may thus be numbered. With how much more dispatch would a letter be communicated by signals which express words, than by signals which express only letters. Words may be forwarded as fast as they can be looked for in a dictionary; and even whilst only an equal number of letters could have been communicated by the present mode. Another advantage resulting from the use of words in telegraphic correspondence is, that the words of the same meaning in the several languages having the same number, correspondence may be carried on from one language into another, which though not grammatically correct, yet would be sufficiently intelligible.

Proper names must be spelt, which may easily be done, every letter having a corresponding number.

Though the use of telegraphs has to this time been confined to military purposes, yet a machine of this kind is well adapted to accelerate commercial communication from one end of the kingdom to the other. The arrival, the departure of vessels, the various transactions of commerce, might be speedily announced, to the very great advantage of trade. By this method inaccessible places might communicate their wants; and correspondents, though at a distance of five or six miles, might erect them for a trifling expense. I made the experiment with one of eight feet by ten, and, with the use of a telescope, I took down every number from a distance of a mile and a half.

## Reference to the Engraving.

This machine is intended to express numbers, which may be seen at a distance, and to which words may be referred at pleasure.

Fig.

*Fig. 1.*

*Fig. 3.*

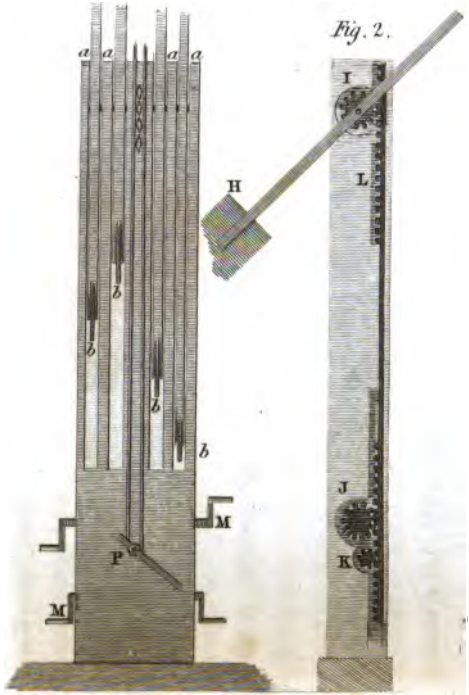


*Fig. 2.*




*Fig. 4.*

Fig. 1 (Plate II.) represents a front view of the machine — it is composed of nine bars or radii, answering to the nine figures of arithmetic, as numbered in the plate. The four polygonal or concentric bars A B C D, which intersect the radii, are for the decimals; thus, A stands for units, B for tens, C for hundreds, D for thousands. Over each of these concentric bars or circles an index, as that marked H, Fig. 2, traverses, which marks the number of thousands, of hundreds, of tens, and of units, as far as ten thousand: for instance, if it is required to make the number 9202, turn the hand H in the circle D of thousands to the radius 9, then the hand H in the circle C of hundreds to the radius 2, then, as there are no tens, turn the hand to the radius 2, upon the circle A of units; but as ten thousands are not sufficient to express the number of words in the English language, two square boards are added in the corners, of which that marked E is equal to 10,000, that marked F to 20,000, and both being shewn together, are equal to 30,000, which, with the numbers made on the circles, bring it up to 40,000, which number is more by many thousands than all the words in the English language.

Fig. 2 is a view of the mechanism which works the signals round: this is done by means of a rack wheel at I, upon which is firmly fixed the hand with its signal board H; this wheel is made to revolve by means of a rack L, which being raised or lowered, makes it go backwards or forwards: this rack is set in motion by the pinion K, to which is fixed a winch, as M, Fig. 3. To prevent the necessity of inspecting the signals, the wheel I, to which is fixed an index, as at N, Fig. 4, is added, which revolving in the same time as the signal board

board H, marks the number of the decimal, so that it may be worked correctly from within doors. O, Fig. 4, is a bolt to stop the hands at any given point, by means of a wheel with four notches Q fixed to the pinion.

Fig. 3 is a side section of the machine; the lines *a a a a* represent boards, upon each of which is fixed the mechanism Fig. 2; *b b b b* are the hands and signal boards, one of which is shewn at H, Fig. 2. The square boards E and F, Fig. 1, are fixed upon iron bars, which pass through the bars or radii 4 and 6, and have each of their ends made to move in holes in the radius 5, and in the frame at *i i*, Fig. 1, upon which they turn a quarter round, by means of cross bars at *g g*, to each end of which ropes or wires *h h* are fastened, and which are connected with two levers, one of which is shewn at P, Fig. 3, the raising or depressing of which makes them appear or disappear as required.

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## *Method of dividing Astronomical and other Instruments, by ocular Inspection; in which the usual Tools for graduating are not employed; the whole Operation being so contrived, that no Error can occur but what is chargeable to Vision, when assisted by the best optical Means of viewing and measuring minute Quantities.*

*By Mr.* EDWARD TROUGHTON.

With a Plate.

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY of LONDON.

IT would ill become me, in addressing myself to the Members of this Society upon a subject which they are so well enabled to appreciate, to arrogate to myself more than may be assigned as my due, for whatever of success

success may have been the result of my long-continued endeavours, exerted in prosecuting towards perfection *the dividing of Instruments immediately subservient to the purposes of Astronomy.* A man very naturally will set a value upon a thing on which so much of his life has been expended; and I shall readily, therefore, be pardoned for saying, that considering some attainments which I have made on this subject as too valuable to be lost, and being encouraged also by the degree of attention which the Royal Society has ever paid to practical subjects, I feel myself ambitious of presenting them to the public through what I deem the most respectable channel in the world.

It was as early as the year 1775, being then apprentice to my brother, the late Mr. John Troughton, that the art of dividing had become interesting to me; the study of astronomy was also new and fascinating; and I then formed the resolution to aim at the nicer parts of my profession.

At the time alluded to, my brother, in the art of dividing, was justly considered the rival of Ramsden; but he was then almost unknown beyond the narrow circle of the mathematical and optical instrument makers; for whom he was chiefly occupied in the division, by hand, of small astronomical quadrants, and Hadley's sextants of large radius. Notwithstanding my own employment at that time was of a much inferior nature, yet I closely inspected his work, and tried at leisure hours, on waste materials, to imitate it. With as steady a hand, and as good an eye as young men generally have, I was much disappointed at finding, that after having made two points, neat and small, to my liking, I could not bisect the distance between them, without enlarging, displacing,

or

or deforming them with the points of the compasses. This circumstance gave me an early dislike to the tools then in use; and occasioned me the more uneasiness, as I foresaw that it was an evil which no practice, care, nor habit could entirely cure: Beam-compasses, spring-dividers, and a scale of equal parts, in short, appeared to me little better than so many sources of mischief.

I had already acquired a good share of dexterity, as a general workman: Of the different branches of our art, that of turning alone seemed to me to border on perfection. This juvenile conceit, fallacious as I afterwards found it, furnished the first train of thoughts, which led to the method about to be described; for it occurred to me, that if I could by any means apply the principle of turning to the art of dividing instruments, the tools liable to objection might be dispensed with. The means of doing this was first suggested by seeing the action of the perambulator or measuring wheel; the surface of the earth presenting itself as the edge of the instrument to be divided, and the wheel of the perambulator as a narrow roller acting on that edge; and hence arose an idea that some easy contrivance might be devised, for marking off the revolutions and parts of the roller upon the instrument. Since the year above-mentioned, several persons have proposed to me, as new, dividing by the roller, and I have been told, that it also occurred long ago to Hook, Sisson, and others; but, as Hatton on watch-making says, "I do not consider the man an inventor who merely thinks of a thing; to be an inventor, in my opinion, he must act successfully upon the thought, so as to make it useful." I had no occasion, however, to have made an apology for acting upon a thought, which, unknown to me, had been previously conceived

conceived by others; for it will be seen in the sequel, how little the roller has to do in the result, and with what extreme caution it is found necessary to employ it.

When a roller is properly proportioned to the radius of the circle to be divided, and with its edge made a small matter conical, so that one side may be too great, and the other side too little, it may be adjusted so exactly, that it may be carried several times around the circle, without the error of a single second; and it acts with so much steadiness, that it may not unaptly be considered as a wheel and pinion of indefinitely high numbers. Yet, such is the imperfection of the edges of the circle and roller, that, when worked with the greatest care, the intermediate parts, on a radius of two feet, will sometimes be unequal to the value of half a minute or more. After having found the terminating point of a quadrant or circle so permanent, although I was not prepared to expect perfect equality throughout, yet I was much mortified to find the errors so great, at least ten times as much as I expected; which fact indicated, beyond a doubt, that if the roller is to be trusted at all, it must only be trusted through a very short arc. Had there been any thing slippery in the action, which would have been indicated by measuring the same part at different times differently, there would have been an end of it at once; but, that not being the case in any sensible degree, the roller becomes an useful auxiliary to fill up short intervals, whose limits have been corrected by more certain means *.

Bird,

* There are two things in the foregoing account of the action of the roller which have a tendency to excite surprise. The first is,

Bird, who enjoyed the undisputed reputation of being the most accurate divider of the age in which he lived, was the first who contrived the means how to render the usual divisions of the quadrant bisectional; which property, except his being unusually careful in avoiding the effects of unequal expansion from change of temperature, chiefly distinguished his method from others who divided by hand. This desirable object he accomplished by the use which he made of a finely divided scale of equal parts. The thing aimed at was, to obtain a point upon the arc at the highest *bisectional number of divisions* from 0, which in his eight feet quadrants was

that the roller should, in different parts of its journey round the circle, measure the latter so differently. One would not wonder, however, if in taking the measure across a ploughed field, it should be found different to a parallel measure taken upon a gravel-walk; and, in my opinion, the cases are not very dissimilar. Porosity of the metal, in one part of the circle more than in the other, must evidently have the same effect; brass unhammered is always porous; and the part, which has felt the effect of two blows, cannot be so dense as other parts which have felt the effect of three; and, should the edge of the circle be indented by *jarring-turning*, it would produce a visible similitude to ploughed ground. Every workman must be sufficiently upon his guard against such a palpable source of error; yet, perhaps, with our greatest care we may not be able to avoid it altogether. The second is, that notwithstanding the inequality above-mentioned, the roller having reached the point upon the circle from whence it set out, should perform a second, third, &c. course of revolutions, without any sensible deviation from its former track; this is not perhaps so easily accounted for. It must be mentioned, that the exterior border of the circle should be *turned rounding*, presenting to the roller a convex edge, whose radius of curvature is not greater than one tenth of an inch. Now, were the materials perfectly inelastic and impenetrable, the roller could only touch the circle in a *point*, and in passing round the circle, it could only occupy a *line* of contact. This in practice is not the case; the circle always

was 1024, = 85° 20′. The extent of the beam-compasses, with which he traced the arc upon the limb of the instrument to be divided, being set off upon that arc, gave the points 0° and 60°; which, being bisected, gave 30° more to complete the total arc. A second order of bisections gave points at 15° distance from each other; but that which denoted 7.5° was most useful. Now, from the known length of the radius, as measured upon the scale, the length of the chord 10° 20′ was computed, taken off from the scale, and protracted from 75° forwards; and the chord of 4° 40′, being ascertained in the same manner, was set off from 90° backwards,

always marks the roller with a broad list, and thereby shews that there is a yielding between them to a considerable amount. The breadth of this list is not less than one fiftieth of an inch; and it follows, that at least 12° of the circle's edge must be in contact at the same time; that the two surfaces yield to each other in depth, by a quantity equal to the *ver. sin.* of half that arc, or $\frac{1}{1200}$ of an inch; and that the circle has always hold of the roller by nearly 1° of the edge of the latter. Whoever has examined the surfaces of metals which have rolled against each other, must have observed that peculiar kind of indentation that always accompanies their action; and there can be no doubt that the particles of a roller, and those of the surface on which it acts, which mutually indent each other, will, upon a second course begun from the same point, indent each other deeper. This is not, however, exactly the case in question; for, whatever of fitting might have taken place between the surfaces of our roller and circle in the first revolution of the former, one should imagine would be obliterated by the fifteen turns which it must repeat over fresh ground. Experience shows, however, as every one will find who tries the experiment with good work, that on coming round to the point of commencement, the roller has the disposition to regain its former track; for, were this not the case, although the commensurate diameters were adjusted so exactly as to be without sensible error in one course, yet a less error than that which is so would become visible, when repeated through many courses.

meeting the chord of 10° 20′ in the continually bisectional arc of 85° 20′. This point being found, the work was carried on by bisections, and the chords, as they became small enough, were set off beyond this point to supply the remainder of the quadrantal arc. My brother, whom I mentioned before, from mere want of a scale of equal parts upon which he could rely, contrived the means of dividing bisectionally without one. His method I will briefly state as follows, in the manner which it would apply to dividing a mural quadrant. The arcs of 60° and 30° give the total arc as before; and let the last arc of 30° be bisected, also the last arc of 15°, and again the last arc of 7° 30′. The two marks next 90° will now be 82° 30′ and 86° 15′, consequently the point sought lies between them. Bisections will serve us no longer; but if we divide this space equally into three parts, the most forward of the two intermediate marks will give us 85°, and if we divide the portion of the arc between this mark and 86° 15′ also into three, the most backward of the two marks will denote 85° 25′. Lastly, if we divide any one of these last spaces into five, and set off one of these fifth parts backwards from 85° 25′, we shall have the desired point at 1024 divisions upon the arc from 0°. All the rest of the divisions which have been made in this operation, which I have called marks because they should be made as faint as possible, must be erased; for my brother would not suffer a mark to remain upon the arc to interfere with his future bisections.

Mr. Smeaton, in a paper to be more particularly noticed presently, justly remarks the want of a unity of principle in Mr. Bird's method; for he proceeds partly on the ground of the protracted radius, and partly upon that

that of the computed chord; which, as Smeaton observes, may or may not agree. Bird, without doubt, used the radius and its parts in order to secure an exact quadrant; but Smeaton, treating exactness in the total arc as of little value to astronomy, would, in order to secure the more essential property of equality of division, reject the radius altogether, and proceed entirely upon the simple principle of the computed chord. The means pursued by my brother, to reach the point which terminates the great bisectional arc, is the only part in which it differs from Bird's method; and I think it is without prejudice that I give it the preference. It is obvious that it is as well calculated to procure equality of division, as the means suggested by Smeaton; at the same time that it is equal to Bird's in securing the precise measure of the total arc. It proceeds entirely upon the principle of the protracted chord of 60° and its subdivision; and the uncertainty, which is introduced into the work by the sparing use which is made of subdivision by 3 and 5, is, in my opinion, likely to be much exceeded by the errors of a divided scale *, and those of the hand and eye, in taking off the computed chords, and applying them to the arc of the instrument to be divided.

Ramsden's well-known method of dividing by the engine unites so much accuracy and facility, that a better can hardly be wished for; and I may venture to say that it will never be superseded, in the division of instruments of *moderate radii*. It was well suited to the time in which it appeared; a time when the improvements

* That Bird's scale was not without considerable errors, will be shewn towards the end of this paper.

made

made in nautical astronomy, and the growing commerce of our country, called for a number of reflecting instruments, which never could have been supplied, had it been necessary to have divided them by hand; however, as it only applies to small instruments, it hardly comes within the subject of this paper.

The method of Hindeley, as described by Smeaton*, I will venture to predict will never be put in practice for dividing astronomical instruments, however applicable it might formerly have been for obtaining numbers for cutting clock-work, for which purpose it was originally intended. It consists of a train of violent operations with blunt tools, any one of which is sufficient to stretch the materials beyond, or press them within their natural state of rest; and, although the whole is done by contact, the nature of this contact is such as, I think, ought rather to have been contrasted with, than represented as being similar to, the nature of the contact used in Smeaton's Pyrometer, which latter is performed by the most delicate touch; and is represented, I believe justly, to be sensible to the ~~10000~~ part of an inch. Smeaton has, however, acquitted himself well, in describing and improving the method of his friend; and the world is particularly obliged to him for the historical part of his paper, as it contains valuable information which perhaps no one else could have written.

The only method of dividing large instruments now practised in London, that I know of, besides my own, has not yet, I believe, been made public. It consists in dividing by hand with beam compasses and spring dividers, in the usual way; with the addition of examining

* Phil. Trans. for 1788.

the

the work by microscopes, and correcting it, as it proceeds, by pressing forwards or backwards by hand, with a fine conical point, those dots which appear erroneous; and thus adjusting them to their proper places. The method admits of considerable accuracy, provided the operator has a steady hand and good eye; but his work will ever be irregular and inelegant. He must have a circular line passing through the middle of his dots, to enable him to make and keep them at an equal distance from the centre. The bisectional arcs, also, which cut them across, deform them much; and, what is worse, the dots which require correction (about two thirds perhaps of the whole) will become larger than the rest, and unequally so, in proportion to the number of attempts which have been found necessary to adjust them. In the course of which operation, some of them grow insufferably too large, and it becomes necessary to reduce them to an equality with their neighbours. This is done with the burnisher, and causes a hollow in the surface, which has a very disagreeable appearance. Moreover, dots which have been burnished up are always ill-defined, and of a bad figure. Sir George Shuckburgh Evelyn, in his paper on the Equatorial *, denominates these "doubtful or bad points;" and (considering the few places which he examines) they bear no inconsiderable proportion to the whole. In my opinion, it would be a great improvement of this method, to divide the whole by hand at once, and afterwards to correct the whole; for a dot forced to its place, as above, will seldom allow the compass-point to rest in the centre of its apparent area;

* Phil. Trans. for 1793.

therefore

therefore other dots made from those will scarcely ever be found in their true places. This improvement also prevents the corrected dots from being injured, or moved, by the future application of the compasses, no such application being necessary.

I will now dismiss this method of dividing, with observing, that it is tedious in the extreme; and, did I not know the contrary beyond a doubt, I should have supposed it to have surpassed the utmost limit of human patience *. When I made my first essay at subdividing with the roller, I used this method, according to the improvement suggested above, of correcting a few primitive points; but even this was too slow for one who had much to do. Perhaps, however, had my instruments been divided for me by an assistant, I might not have grudged to have paid him for the labour of going through the whole work by the method of adjustment; nor have felt the necessity of contriving a better way.

I might now extend the account of my method of dividing to a great length; by relating the alterations which the apparatus has undergone during a long course

* At the time alluded to, the double microscopic micrometer was unknown to me, and I did not learn its use, for these purposes, till the year 1790, from General Roy's description of the large theodolite. Previous to that time, I had used a frame which carried a single wire very near the surface to be divided; this wire was moveable by a fine micrometer screw, and was viewed by a single lens inserted in the lower end of a tube, which, for the purpose of taking off the parallax, was 4 inches long. The greatest objection to this mode of constructing the apparatus is, that the wire being necessarily exposed, is apt to gather up the dust; yet it is preferable to the one now in use, in cases where any doubt is entertained of the accuracy of the plane which is to receive the divisions.

of

Fig. 7.

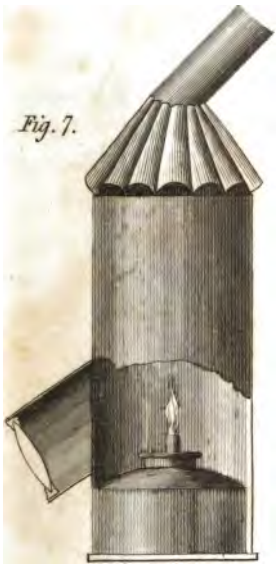


Fig. 5.

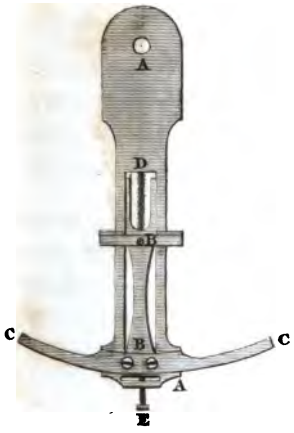
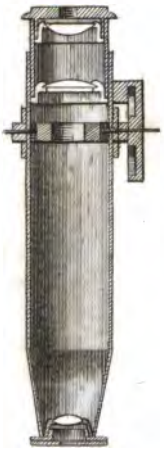



Fig. 6.



years *, and the various manner of its application, before I brought it to its present state of improvement; but I think I may save myself that trouble, for truly I do not see its use: I will, therefore, proceed immediately to a disclosure of the method, as practised on a late occasion, in the dividing of a four feet meridian circle, now the property of Stephen Groombridge, Esq. of Blackheath.

The surface of the circle which is to receive the divisions, as well as its inner and outer edges, but especially the latter, should be turned in the most exact and careful manner; the reason for which will be better understood, when we come to describe the mode of applying the roller; and, as no projection can be admitted beyond the limb, if the telescope, as is generally the case, be longer than the diameter, those parts which extend further must be so applied, that they may be removed during the operation of dividing. Fig. 1 and 2 (Plate III.) represent the principal parts of the apparatus; Fig. 1 shewing the plan, and Fig. 2 the elevation; in both of which the same letters of reference are affixed to corresponding parts, and both are drawn to a scale of half dimensions †. AA is a part of the circle, the surface of which is seen in the plan, and the edge is seen in the elevation. BBB is the main plate of the apparatus, resting with its four feet *aaaa* upon the surface of the arc; these feet, being screws, may be adjusted so as to take

* The full conception of the method had occupied my mind in the year 1778; but as my brother could not be readily persuaded to relinquish a branch of the business to me in which he himself excelled, it was not until September 1785 that I produced my first specimen, by dividing an astronomical quadrant of two fee tradius.

† Reduced in the plate.

equal shares of the weight, and then are fastened by nuts below the plate, as shewn in Fig. 2. C C and D D are two similar plates, each attached to the main plate, one above and the other below, by four pillars; and in them are centred the ends of the axis of the roller E. F and G are two friction wheels, the latter firmly fastened to B, but the former is fixed in an adjustable frame, by means of which adjustment these wheels and the roller E, may be made to press; the former on the interior, and the latter on the exterior edge of circle, with an equal and convenient force *. At the extremities of the axis of the roller, and attached to the middle of the plates C and D, are two bridges, having a screw in each; by means of which an adjustment is procured for raising or lowering the roller respecting the edge of the circle, whereby the former, having its diameter at the upper edge about .001 of an inch greater than at the lower edge (being, as before described, a little conical), it may easily be brought to the position where it will measure the proper portion of the circle.

Much experience and thought upon the subject have taught me, that the roller should be equal to one sixteenth part of the circle to be divided, or that it should revolve once in 22° 30′; and that the roller itself should be divided into sixteen parts; no matter whether with absolute truth, for accuracy is not at all essential here. Each of such divisions of the roller will correspond with an angle upon the circle of 1° 24′ 22,″5, or $\frac{1}{256}$ part of the circle. This number of principal divisions was

* Sufficient spring for keeping the roller in close and uniform contact with the edge of the circle, is found in the apparatus, without any particular contrivance for that purpose; the bending of the pillars of the secondary frames and of the axis of the roller, chiefly supplies this property.

chosen,

chosen, on account of its being capable of continual bisection; but they do not fall in with the ultimate divisions of the circle, which are intended to be equal to 5′ each.

The next thing to be considered is, how to make the roller measure the circle. As two microscopes are here necessary, and those which I use are very simple, I will in this place give a description of them. Fig. 6 is a section of the full size *, and sufficiently explains their construction, and the position of the glasses; but the micrometer part and manner of mounting it, are better shewn at H, in Fig. 1 and 2. The micrometer part consists of an oblong square frame, which is soldered into a slit, cut at right angles in the main tube; another similar piece nicely fitted into the former, and having a small motion at right angles to the axis of the microscope, has at one end a cylindrical guide pin, and at the other a micrometer screw; a spring of steel wire is also applied, as seen in the section, to prevent play, by keeping the head of the micrometer in close contact with the fixed frame. This head is divided into one hundred parts, which are numbered each way to 50; the use of which will be shewn hereafter. A fine wire is stretched across the moveable frame, for the purpose of bisecting fine dots. Two of these microscopes are necessary; also a third, which need not have the divided head, and must have in the moveable frame two wires crossing each other at an angle of about 30°; this microscope is shewn at I, Fig. 1. In the two first micrometers, a division of the head is of the value of about 0″,2, and the power and distinctness such, that when great care is taken, a much greater error than to

* Reduced in the Plate.

the amount of one of these divisions cannot well be committed in setting the wire across the image of a well made dot. The double eye-glass has a motion by hand, for producing distinct vision of the wire; and distinct vision of the dots is procured by a similar adjustment of the whole microscope.

The first step towards sizing the roller, is to compute its diameter according to the measure of the circle, and to reduce it agreeably thereto, taking care to leave it a small matter too large. The second step is, after having brought the roller into its place in the plate B B, to make a mark upon the surface of the circle near the edge, and a similar one upon the roller, exactly opposite each other; then carry the apparatus forward with a steady hand, until the roller has made sixteen revolutions: If, now, the mark upon the roller, by having over-reached the one upon the circle, shews it to be much too large, take it out of the frame and reduce it by turning accordingly: When by repeating this, it is found to be very near, it may be turned about .001 of an inch smaller on the lower edge, and so far its preparation is completed. The third and last step is, the use and adaptation of the two microscopes; one of these must take its position at H in Fig. 1, viewing a small well defined dot made for the purpose on the circle; the other, not represented in the figure, must also be fixed to the main plate of Fig. 1, as near to the former as possible, but viewing one of the divisions on the roller. With a due attention to each microscope, it will now be seen to the greatest exactness when, by raising or depressing the roller, its commensurate diameter is found.

Fig. 3 is a representation of the apparatus for transferring the divisions of the roller to the circle. It consists

consists of two slender bars, which, being seen edgewise in the figure, have only the appearance of narrow lines; but, when looked at from above, they resemble the form of the letter A. They are fastened to the main frame, as at W and Z, by short pillars, having also the off leg of the angle secured in the same manner; Y is a fine conical steel point for making the dots, and X is a feeler, whereby the point Y may be pressed down with a uniform force, which force may be adjusted, by bending the end of the bar just above the point, so as to make the dots of the proper size. The point Y yields most readily to a perpendicular action; but is amply secured against any eccentric or lateral deviation.

The apparatus, so far described, is complete for laying our foundation, *i. e.* making 256 primary dots; no matter whether with perfect truth, or not, as was said respecting the divisions of the roller; precision in either is not to be expected, nor wished; but it is of some importance that they should be all of the same size, concentric, small, and round. They should occupy a position very near the extreme border of the circle, as well to give them the greatest radius possible, as that there should be room for the stationary microscope and other mechanism, which will be described hereafter.

It must be noticed, that there is a clamp and adjusting screw attached to the main plate of Fig. 1; but, as it differs in no respect from the usual contrivances for quick and slow motion, it has been judged unnecessary to incumber the drawing with it.

Now, the roller having been adjusted, with one microscope H upon its proper dot on the circle, and the other microscope at the first division on the roller; place the apparatus of Fig. 3 so that the dotting point Y may stand

stand directly over the place which is designed for the beginning of the divisions. In this position of things, let the feeler X be pressed down, until its lower end comes in contact with the circle; this will carry down the point, and make the first impression, or primary dot, upon the circle; unclamp the apparatus, and carry it forwards by hand, until another division of the roller comes near the wire of the microscope; then clamp it, and with the screw motion make the coincidence complete; where again press upon the feeler for the second dot: proceed in this manner until the whole round is completed.

From these 256 erroneous divisions, by a certain course of examination, and by computation, to ascertain their absolute and individual errors, and to form these errors into convenient tables, is the next part of the process, and makes a very important branch of my method of dividing.

The apparatus must now be taken off, and the circle mounted in the same manner, that it will be in the Observatory. The two microscopes, which have divided heads, must also be firmly fixed to the support of the instrument, on opposite sides, and their wires brought to bisect the first dot, and the one which should be 180° distant. Now, the microscopes remaining fixed, turn the circle half round, or until the first microscope coincides with the opposite dot; and, if the other microscope be exactly at the other dot, it is obvious that these dots are 180° apart, or in the true diameter of the circle; and if they disagree, it is obvious that half the quantity by which they disagree, as measured by the divisions of the micrometer head, is the error of the opposite division; for the quantity measured is that by which the greater portion of the circle exceeds the less. It is convenient

venient to note these errors + or —, as the dots are found too forward or too backward, according to the numbering of the degree; and for the purpose of distinguishing the + and — errors, the heads, as mentioned before, are numbered backwards and forwards to fifty. One of the microscopes remaining as before, remove the other to a position at right angles; and considering for the present both the former dots to be true, examine the others by them; *i. e.* as before, try by the micrometer how many divisions of the head the greater half of the semicircle exceeds the less, and note half the quantity + or —, as before, and do the same for the other semicircle. One of the micrometers must now be set at an angle of 45° with the other, and the half differences of the two parts of each of the four quadrants registered with their respective signs. When the circle is a vertical one, as in the present instance, it is much the best to proceed so far in the examination with it in that position, for fear of any general bending or spring of the figure; but for the examination of smaller arcs than 45°, it will be perfectly safe, and more convenient to have it horizontal; because the dividing apparatus will then carry the micrometers, several perforations being made in the plate B for the limb to be seen through at proper intervals. The micrometers must now be placed at a distance of 22° 30′, and the half differences of the parts of all the arcs of 45° measured and noted as before; thus descending by bisections to 11° 15′, 5° 37′ 30″, and 2° 48′ 45″. Half this last quantity is too small to allow the micrometers to be brought near enough; but it will have the desired effect, if they are placed at that quantity and its half, *i. e.* 4° 13′ 7″,5; in which case the examination, instead of being made

at

at the next, will take place at the next division but one, to that which is the subject of trial. During the whole of the time that the examination is made, all the dots, except the one under examination, are for the present supposed to be in their true places; and the only thing in this most important part of the business, from first to last, is to ascertain with the utmost care, in divisions of the micrometer head, how much one of the parts of the interval under examination exceeds the other, and carefully to tabulate the half of their difference.

I will suppose that every one, who attempts to divide a large astronomical instrument, will have it engraved first. Dividing is a most delicate operation, and every coarser one should precede it. Besides, its being numbered is particularly useful to distinguish one dot from another; thus, in two tables which I have calculated of errors, the side columns give significant names to every dot, in terms of its value to the nearest tenth of a degree, and the mistaking of one for another is rendered nearly impossible.

The foregoing examination furnishes materials for the construction of the table of half differences, or apparent errors*. The first line of this table consists of two varieties; *i. e.* the micrometers were at 180° distance for obtaining the numbers which fill the columns of the first and third quadrant; and at 90°, for those of the second and fourth quadrant. The third variety makes one line, and was obtained with a distance of 45°: the fourth consists of two lines, with a distance of 22° 30′: the fifth of

* If the table of real errors be computed as the work of examination proceeds, there will be no occasion for this table at all; but I think it best not to let one part interfere with another, and therefore I examine the whole before I begin to compute.

four

four lines, with a distance of 11° 15′: the sixth of eight lines, with a distance of 5° 37′ 30″: the seventh of sixteen lines, with a distance of 2° 48′ 45″: and the eighth and last variety, being the remainder of the table, consists of thirty-two lines, and was obtained with a distance of 4° 13′ 7″,5.

The table of apparent errors, or half differences, just explained, furnishes data for computing the table of real errors. The rule is this; let $a$ be the real error of the preceding dot, and $b$ that of the following one, and $c$ the apparent error, taken from the table of half differences, of the dot under investigation; then is $\frac{a+b}{2}+c=$ its real error. But, as this simple expression may not be so generally understood by workmen as I wish, it may be necessary to say the same thing less concisely. If the real errors of the preceding and following dots are both + or both —, take half their sum and prefix thereto the common sign; but, if one of them is +, and the other —, take half their difference, prefixing the sign of the greater quantity: again, if the apparent error of the dot under investigation has the same sign of the quantity found above, give to their sum the common sign, for the real error; but if their signs are contrary, give to their difference the sign of the greater for the real error. I add a few examples.

*Example I.*

For the first point of the second quadrant.

| | |
|---|---|
| Real error of the first point of the first quadrant | 0,0 |
| Real error of the first point of the third quadrant | —6,9 |
| Half sum or half difference | —3,4 |
| Apparent error of the dot under trial | 12,2 |
| Real error | + 8,8 |

*Example II.*

For the point 45° of the second quadrant.

| | |
|---|---|
| Real error of the first point of the quadrant | + 8,8 |
| Real error of the last point of the quadrant | —6,9 |
| Half difference | + 0.9 |
| Apparent error of the dot under trial | —8,9 |
| Real error | —8,0 |

*Example III.*

Point 88°,6, or last point, of the third quadrant.

| | |
|---|---|
| Real error of the point 84°,4 of the third quadrant | —21,0 |
| Real error of the point 2°,8 of the fourth quadrant | — 2,9 |
| Half sum | —11,9 |
| Apparent error of the dot under trial | — 4,0 |
| Real error | —15,9 |

*Example IV.*

Point 88°,6, or last, of the fourth quadrant.

| | |
|---|---|
| Real error of the point 84°,4 of the fourth quadrant | —21,6 |
| Real error of the point 2°,8 of the first quadrant | —10,2 |
| Half sum | —15,9 |
| Apparent error of the dot under trial | + 9,5 |
| Real error | — 6,4 |

It is convenient, in the formation of the table of real errors, that they should be inserted in the order of the numbering of the degrees on their respective quadrants; although their computation necessarily took place in the order in which the examination was carried on, or according to the arrangement in the table of apparent errors.

errors. The first dot of the first quadrant having been assumed to be in its true place; the first of the third quadrant will err by just half the difference found by the examination; therefore these errors are alike in both tables. The real error of the first dot of the second quadrant comes out in the first example; that of the fourth was found in like manner, and completes the first line. It is convenient to put the error of the division 90° of each quadrant at the bottom of each column, although it is the same as the point 0° on the following quadrant. The line of 45° is next filled up; the second example shews this; but there is no occasion to dwell longer upon this explanation; for every one, who is at all fit for such pursuits, will think what has already been said fully sufficient for his purpose. However, I will just mention that there can be no danger, in the formation of this table, of taking from a wrong line real errors which are to be the criterion for finding that of the one under trial; because they are in the line next to it; the others, which intervene in the full table, not being yet inserted. The last course of all is, however, an exception; for, as the examining microscopes could not be brought near enough to bisect the angle 2° 48′ 45″, recourse was had to that quantity and its half; on which account the examination is prosecuted by using errors at two lines distance, as is shewn in the two last examples.

When the table of real errors is constructed, the other table, although it is of no further use, should not be thrown away; for, if any material mistake has been committed, it will be discovered as the operation of dividing is carried on; and, in that case, the table of

apparent errors must be had recourse to; indeed, not a figure should be destroyed until the work is done.

Respecting the angular value of the numbers in these tables, it may be worth mentioning, that it is not of the least importance; 100 of them being comprised in one revolution of the micrometer screw; and, in the instance before me, 5,6 of them made no more than a second. It is not pretended that one of these parts was seen beyond a doubt, being scarcely $\frac{1}{10000}$ of an inch, much less the tenths, as exhibited in the tables; but, as they were visible upon the micrometer heads, it was judged best to take them into the account.

TO BE CONCLUDED IN OUR NEXT.

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## *On the Use of Soda in the Soap Works at Marseilles.*

*By M.* LAURENS.

From the ANNALES DE CHIMIE.

AMONG the advantages that technical chemistry yields every day to society, we ought, at Marseilles, to insist the most particularly on those that may be drawn from this science in the manufactory of soap. Although this truth is, in general, but little acknowledged by the manufacturers of this city, it is not less true that it is only from chemistry that they can expect to attain any improvement of the processes used for obtaining the article that they throw into trade. Let us now examine the employment made of soda, which is one of the most useful of the substances that constitute soap.

Nobody is ignorant that there exists a great variation in the nature of the substances which pass in trade under the

the name of soda, as well as in the proportion of the alkali that they contain. This variation being well known, leads the buyer always to fix his choice upon those parcels which contain the largest proportion of alkali, as being the only ingredient, which acting upon oil, produces soap. The manufacturer of soda therefore endeavours to fix the price of his goods according to the quantity of alkali that they contain: but is this object always attained? Experience shews the contrary. The appearance and taste, which are the only means to which they have recourse, are not sufficient for them to obtain this end. The parcels of soda exhibit, as I have already mentioned, such a variety in their principles that it is impossible to choose the best with any certainty, unless they are previously submitted to an analysis. This analysis is besides still more indispensible when it is desired to determine the causes of all the phænomena that take place in the manufacture of soap. Soda being the most valuable of the substances whose quantity it is proposed to determine, when these matters are analysed, the manufacturer ought to be well aware how important it is that he should determine its proportion in an exact manner. It is therefore meant to give in this place a process, that a manufacturer who is entirely ignorant of chemistry may, among the different chemical methods that might be employed, use for this purpose.

This process is founded upon the capacity for saturation of soda. A given quantity of the soda is taken and reduced to powder, which is elixiviated by water, until every thing that the liquid will dissolve is taken up: a sufficient quantity of muriatic acid to saturate the alkali held in solution is then to be added. When the soda is saturated, which may be known by the ceasing of the effer-

effervescence, an account is taken of the quantity of muriatic acid that has been absorbed; this quantity is always the more considerable as the liquid was more alkaline. By operating in this manner upon different specimens of soda, the relative quantities of soda that they contain will be shewn; and if it is desired also to determine the real weight of the alkali, a fixed term may be obtained by saturating a given quantity of pure carbonate of soda with muriatic acid, of the same degree of strength.

By means of this simple experiment, the manufacturer of soap may convince himself that the prices of the different sorts of soda found in trade are not always founded upon the proportion of alkali and salts that they may contain.

The sulphuretted soda which analysis shews to be contained in them augments their price; and the manufacturer, on buying different sorts, frequently pays very dear for the sulphuret that they contain. If, however, the experiment is made, it will be soon seen that the sulphuret is of no use in the saponification of the oil, and cannot be of any utility in the manufacture. To separate the soda from the sulphuret, as has been lately proposed by Mr. Figuier of Montpellier, in the Annales de Chimie, would only offer to the manufacturer a process which the small quantity of sulphuretted soda that is contained in the common soda would not allow him to employ, with any sensible saving of his expenses.

But, although sulphuretted soda does not have any action in the formation of soap from oil, it produces a chemical phænomenon that is not known to the manufacturers at Marseilles, notwithstanding it is very important

portant for them to know it. The formation of hydrosulphuretted oxyd of iron is here meant, a substance to which the coloured soap known in the trade by the name of pale-blue soap *(savon bleu pâle)* owes its peculiar colour. This blue colour, which is so much sought after at present, and increases the price of the soda that is able to produce it, may be easily obtained by mixing together green sulphate of iron and a hydroguretted alkaline sulphuret *. It is in the soap manufactories at Marseilles, that the existence of this chemical phænomenon may be perceived every day. The author himself has produced it by adding a hydroguretted sulphuret to soap already made and treated as is always done with sulphate of iron. The property of destroying the blue, according to the expression of the manufacturers, a property which they ascribe to some kinds of soda, is a mere nonentity; it is only the absence of sulphuret in those kinds of soda to which experience attributes the impossibility of obtaining by their means the soap commonly known by the name of pale blue.

The colour of this soap being, as already mentioned, very much in request among the manufacturers at Marseilles, and from the several chemical phænomena which it occasions, having an effect upon the sale of the soap sent into the country, several observations will be here given, which have been made in the soap manufactories of this town, as follows.

If one part of hydroguretted alkaline sulphuret, and four parts of green sulphate of iron are added to the soap, it will be found that the hydrosulphuretted oxyd of iron

* The hydroguretted sulphuret of potash has been frequently employed as well as the hydroguretted sulphuret of soda; both of them acted in a manner that was perfectly similar.

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contained in the soap, loses the blue colour that seems to characterise it. It becomes of a rusty aspect. This effect has been observed in the soap manufactories, when they use those kinds of soda that contain but little of the sulphuret.

If, instead of using the above proportions, two parts of sulphate of iron, and one of hydroguretted alkaline sulphuret are used, the soap acquires a fine blue colour; the surface only of which is altered by the air, by which alteration the rusty appearance is exhibited as in the former case. It is in those cases in which this sulphuretted oxyd exists in the soap, that the soap is covered with what is called an Isabella-colour mantle *.

If, again, on decomposing equal quantities of hydroguretted sulphuret, and of sulphate, the product is compared with the two former, a sensible difference will be observed. The air alters it less rapidly.

Lastly, two parts of hydroguretted sulphuret and one of sulphate being mixed together, the product obtained does not exhibit the same phenomena as the several hydrosulphuretted oxyds already mentioned. It is less altered by the air than the last described, and, when altered, it exhibits only that bluish colour to which the mantle so much in request is owing.

The differences here observable in the results of these experiments, are remarked every day in the making of pale blue soap. The varieties that this soap constantly exhibits, or may be made to exhibit in respect to the colour which characterises it, is in reality, not unknown. It is known that this colour sometimes disappears in the

* In general, by "mantle" is expressed the alteration which the air produces on the hydrosulphuretted oxyd of the soda contained in the pale blue soap. This mantle is Isabella colour when it is rusty.

course

course of the manufacture, although sulphuretted varieties of soda are used in the process. Nor are the manufacturers ignorant of the different chemical appearances which the alteration occasioned by the action of the air gives to the hydrosulphuretted oxyd of iron contained in the soaps. All these chemical effects, and several others not here mentioned, may, by considering the above experiments, be very easily explained. The sulphuret contained in the common kinds of soda is in an infinity of proportions; and it is on the proportions of this sulphuret, that the phenomena relative to the colouring of marbled soap depends. The manufacturer himself has been convinced of this truth, as he has found by repeated trials, that an excess of sulphate of iron always produces the Isabella colour mantle which he wishes to avoid.

It results, therefore, from these observations, that by making experiments on the colouring of marbled soaps, the existence of all the physical properties, otherways useless, which are sought after in respect to this soap, may be discovered. But this cannot be done unless the manufacturer is able to appreciate with exactness the quantities of sulphate, and of hydroguretted sulphuret, that he uses. It is therefore evident how necessary it is to lay aside the use of those kinds of soda, which, containing little or no alkali, are nevertheless employed to produce the colour that is required in pale blue soap, and which colour is at present considered as a proof that the soap is not adulterated. As, however, it is possible to superadd this colour, without, as we may say, any charge, it is evident that it is only the quantity of alkali and salts contained in the different kinds of soda, which

the manufacturer ought to consider in fixing a value upon them.

*Remarks by the Editors of the Annales de Chimie.*

The process by which M. Laurens proposes to determine the quantity of alkali contained in the common kinds of soda is a very good one; it is the same as M. Vauquelin formerly proposed for the common kinds of potash, and which he mentioned might serve equally well for the common kinds of soda.

It would certainly be very proper for soap manufacturers to examine the strength of their soda, by means of this simple experiment, every time they purchase a new parcel: they would then be always certain of employing the proper quantity of alkali to convert the oil into soap.

As to the hydroguretted sulphuret which is found in the common kinds of soda, there can be no doubt but that it produces a very sensible effect upon the colour of the marbling of the soap.

Sulphuretted hydrogen unites with iron and oil, and produces a greenish blue matter that does not combine with the soap; but, being disseminated through it by the boiling and coagulation, produces the marbling.

M. Vauquelin, and M. Auzilly, a skilful soap manufacturer at Marseilles, are perfectly convinced of this, from experiments which they have made together.

If a considerable quantity of marbled (mottled) soap newly prepared, is treated with alkohol, or spirit of wine, with the assistance of heat, the substance that remains undissolved is this combination of oxyd of iron, sulphuretted hydrogen and oil.

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When okers are employed to make red soap, there is also formed a combination of oil, and oxyd of iron, and even of alumine which does not unite with the soap; but the sulphuretted hydrogen does not unite with the iron, because it does not find it in a convenient state for that purpose.

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## *On the Experiments of M.* Chenevix, *and those of M.* Descostils, *in respect to Platina.*

*By M.* C. L. Berthollet.

From the Annales de Chimie.

M. Chenevix published, in the Philosophical Transactions, a great number of experiments upon the combination of platina with quicksilver; from whence it appeared, that this alloy, when the ingredients were in certain proportions, could sustain the most violent heat without the quicksilver being separated from it. The alloy was also fusible, and had some resemblance to palladium. That celebrated chemist wished his experiments to be repeated and confirmed, more especially as Messrs. Rose and Gehlen had obtained results which were contrary to his own. He was desired to come, and make the experiments in concert with M. Descostils, in the author's laboratory at Arcueil.

M. Chenevix thought the following experiment, already described by him (Phil. Trans. 1805.) to be the most proper to clear up the subject.

"When dilute nitric acid is boiled upon a large proportion of quicksilver, nitrate of quicksilver at the minimum of oxydisement is obtained. If this is poured into

a muriatic solution of platina, a precipitate is formed which is composed of platina and quicksilver united with muriatic acid; which, on being washed, and reduced with a little borax in a crucible lined with charcoal, yields a metallic button. This button, dissolved in nitro-muriatic acid, is precipitable by green sulphate of iron."

This process was adhered to, and there was obtained, as is there mentioned, a well-melted metallic button, whose specific gravity was about 17.

M. Descostils having boiled a mixture of green sulphate of iron with a solution of platina prepared in such a manner as to have but a slight excess of acid, an abundant precipitate was thrown down, so that this property appears also to belong to platina itself.

There remained another difference, which was, that platina precipitated with quicksilver had the property of melting by the action of heat; which indicated a considerable difference between the button thus obtained, and the platina that had not received the same preparation.

M. Descostils, in the interval between this meeting and the next, tried by himself to melt pure platina by means of borax in a crucible lined with lamp-black, and he obtained a button like that which the mixed precipitate had yielded, and of the same specific gravity.

It was shewn by this experiment, which was repeated, that platina may be melted by means of borax and charcoal: on dissolving a part of the button, M. Descostils extracted from it the boracic acid.

Platina, therefore, can combine with the whole or some part of the borax, and this alloy has a perfectly metallic appearance.

appearance. It is hard, very brittle, and has a crystalline aspect internally. M. Descostils has since observed similar phenomena with other metals.

The mixt precipitate, without the addition of charcoal or borax being exposed to the most violent heat of a forge, did not melt, so that M. Chenevix has learned that the property of melting did not arise from the quicksilver with which the platina had been precipitated, but from the charcoal, or borax. And he himself had observed in his first paper, that platina might be fused by means of borax, most probably in a lined crucible, as now mentioned.

Here are two substances, borax and charcoal, whose actions ought to be distinguished. Of course M. Descostils tried pure platina with charcoal in a crucible, and found that charcoal was sufficient to produce the fusion.

A button obtained in this manner, at Arcueil, received an augmentation of rather more than 0.03, arising from the charcoal that combined with the metal. Its specific gravity was 18. The carburet is very hard, very brittle, internally brilliant and lamellar.

M. Descostils has found that borax without charcoal does not cause the fusion of platina; and nevertheless, when charcoal is added, the borax, or more probably the boracic acid, combines with the platina.

He means to publish the experiments which these observations have occasioned, and which he intends to extend.

## *On the Combination of Iron with Potash.*

*By M.* HASSENFRATZ.

From the JOURNAL DES MINES.

THE beautiful experiments by which the two experienced chemists Gay-Lussac and Thenard have been enabled to decompose potash and soda by means of iron, and to obtain metals which easily combine with the iron, are known. Alloys are thus formed from whence nitrate of potash is obtained when they are treated with nitric acid.

It is also known that the iron obtained in France is most usually melted with charcoal, which contains a more or less considerable proportion of potash, and that it is subsequently refined with the same fuel to produce bar iron; from whence it follows that it is very probable that the potash contained in the charcoal is reduced, and afterwards combined with the iron, during the operations that it undergo.

One thousand parts of oak charcoal yield above 8 parts of salt, of beech 5, of elm 20, of aspin 6, of fir 2, &c. The average of charcoal yields 7 per mille of saline particles. If, then, 100 parts of iron consume on an average 500 of charcoal, it will follow that 2 or 3 *per cent.* of this new metal may combine with the iron during the manufacture.

The small proportion of the new metal that can combine with the iron during the different operations that it undergoes, might render those metallurgists easy, who incline to attribute a bad effect to it, if we did not know beforehand that equally minute quantities of phospho-

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rus render iron brittle in the cold, and of sulphur or copper render it brittle when red.

It was difficult to discover the influence of this new metal upon the goodness of iron, from the small trials of the combination of potash and iron, because the alloys obtained were too small to be forged; yet notwithstanding the smallness of the ingots of potassed iron which have been melted, some chemists have believed that this combination was brittle. When cold short iron is refined, at Zinswiller (Lower Rhine) with lime and potash, iron of a good quality is obtained if the proportions of the substances added in the refining be properly managed, but the iron is quite crude *(rouverain)* when they are employed in too great a proportion; from whence it follows that lime and potash are able to render iron brittle.

This opinion of some chemists who suppose that combination with potash probably renders iron brittle, and the trial on a large scale at Zinswiller which leads us to conclude that potash renders iron crude, in some measure, obliges metallurgists to determine, by direct and positive experiments, the real influence of potash in its combination with iron.

The author being engaged, at this very time, by an order of his excellency the Minister of the Interior, which was communicated by the Board of Mines, in writing on the art of smelting and working iron, it became natural for him to occupy himself on this question.

He, therefore, desired the two celebrated chemists to whom we owe the discovery of the reduction of potash by iron, to send him one of the gun-barrels in which they had repeatedly performed their experiments at the

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Polytechnic School. They had the goodness to choose out one that was still lined internally with the potassed iron, and which this combination with potash had rendered so fusible, that it had melted during their experiments.

The iron of this gun barrel, penetrated with potash, was tried in the presence of the author, and Leboullenger, a pupil in the practical school of Mines, by Roza, a saw-maker, usually employed by the Board of Mines to try the different specimens of iron and steel that they sent to him. The following was the result of this trial:

The gun barrel was heated, and flattened for the space of a decimeter (4 inches) in length on each side of the part that had been melted by the united action of potash and heat.

In this flattening of the gun barrel, a portion of super-potassed iron was detached, and saved, weighing 4 grammes (60 grains); it was brittle when cold; it exhibited in the broken part a mixture of a brown and white substance. The last had a metallic splendour, and hammered very easily when it was separated from the brown substance. After 24 hours exposure to the air, the mass was covered with the moisture which it had attracted from the atmosphere.

The flattened and heated gun barrel was perfectly well welded and forged, it spread under the hammer as easily as cold short iron; it was bent, twisted, and unbent again several times without the smallest crack being to be perceived.

A small bar, a centimetre ($\frac{4}{10}$ of an inch) thick, was also bent backwards and forwards while cold, but it broke after several trials. The external surface of the iron was dead white, like platina; the broken surface shewed a fine grained white cord much squeezed together

ther about 2 or 4 millimetres (0.078 to 0.156 inch) broad: this cord enveloped a brown spot above 5 or 7 millimetres (0.195 to 0.273 inch) broad. This brown substance being separated from the white cord, to which it had only a slight adhesion, was composed of white and brown grains slightly united together. It was formed of that internal stratum of the gun barrel which had been the most exposed to the action of the potash. The external iron was soft, easily filed, and flattened when cold.

Another bar forged and drawn out was tempered, after having been exposed to a cherry red heat. The tempered surface was blistered like steel, it had become hard to the file, and the metal preserved its malleability; it did not break until it had been bent several times; the broken surface had the same appearance as that of the iron before it was tempered.

From these trials, it may be concluded that iron may be combined with potash in the gun barrel in two different proportions: one *ad minimum*, which gives the iron a white colour resembling that of platina, the other *ad maximum*, which gives it a brown colour mixed with white points.

Potashed iron *ad minimum* works very easily, either cold or hot, is more malleable than iron, and acquires hardness by tempering without becoming brittle like steel; and of course it is extremely probable that the small quantity of potash that combines with the iron, when it is smelted with charcoal, only helps to ameliorate its quality.

Potashed iron *ad maximum* takes a more or less deep brown colour, mixed with white points more or less large; in this state the particles have but little cohe-

sion, it is cold short, and also very probably brittle when hot.

One trial on the combination of potash with iron can indeed give some idea of the new properties that the metal acquires during or after the smelting; but it would be too hasty to form any conclusion respecting the properties of potashed iron from a single trial. We must wait therefore until farther experiments have confirmed the whole, or invalidated in some parts, the results here related, and added some new circumstances; for, then being better instructed, we may speak with greater certainty.

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*On the Use of Violet Pickle as a Re-agent; and on the Utility of salting the Vegetables which it is intended to distil. By M.* DESCROIZILLES, *Senior.*

From the ANNALES DE CHIMIE.

THE re-agent most usually employed in chemical experiments for the purpose of detecting the presence of acids, uncombined alkalies, or even alkaline subcarbonates, is syrop of violets. It is also this syrop that has been recommended by the author to use with his alkalimetre, in his essay on the alkalies, of which an abstract was published in the Annales de Chimie for June 1806. In this essay it was stated, that the common alkalies of the shops ought to be denominated supersaturated carbonates; but upon the authority of some chemists, those denominations are now changed, and the names of subcarbonates substituted in lieu of them.

This

This re-agent is, however, subject to several inconveniences. If it be exposed to a rather warm temperature, it ferments, the cork of the bottle flies out, a part of the syrop runs over, and the remainder, after being reddened more or less by the carbonic acid that is formed, dries up into a mass of small crystals. It very frequently happens that flies and other insects, being attracted towards it, are drowned in it, putrefy, and alter the syrop. It was therefore conceived, that a pickle of violets might be substituted for it, and as it answered upon trial, the following is the mode of preparing it.

Pour upon the petals of violets, which have been slightly squeezed into a very small pewter measure, double their weight of boiling water, cover the vessel, and expose it for some hours to a heat rather superior to that of baths, and then pass the water through a very clean cloth, squeezing it strongly. Afterwards weigh the infusion very exactly, and add to it the third part of its weight of common salt. The finest white salt is to be preferred, because it contains little or nearly no muriate with an earthy base, which might affect the colour. This pickle is of a fine deep violet blue, and being kept in a corked bottle, it may be kept without any alteration, although it is exposed to different temperatures, and even to the rays of the sun: as a re-agent it is preferable to the best syrop of violets. 100 parts of the syrop contain 66 of sugar, which frequently contains lime; in 100 parts of the pickle there are only 25 of salt. There is some reason to suppose that several other blue flowers, such as those of flag, larkspur, &c. would also yield a pickle of sufficient accuracy: the latter, indeed, has been tried with complete success.

In order to use this blue pickle, the end of a small splinter or a broken match is dipped into it, and then applied to a plate. By repeating this manœuvre the middle of a plate will hold thirty spots for trials, each of which does not consume a quarter of a drop, so that a few decigrammes of this pickle will serve to make numerous trials in the course of the year.

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It appears, that in general the usefulness of applying common salt to preserve those vegetables which are brought from a distance for the use of apothecaries or perfumers has not been sufficiently appreciated. Hilaire Marin Rouelle, under whom the author was educated, perfumed his laboratory, during the whole of his course of chemistry in the winter of 1775, by distilling the roses he had salted in the preceding June. The rose water that he obtained from them formed, by the addition of a little sugar and alcohol, a very pleasant liquor. A vessel filled with salted roses has been kept for the last three years in the author's laboratory. The perfume of these roses has not lost any thing of its agreeableness or of its strength. The salting was performed in the following manner.

Take a chiliogramme and a half (3 lbs.) of roses, rub them for two or three minutes with half a chiliogramme (1 lb.) of common salt. The flowers being bruised by the friction of the grains of the salt, yield their juice, so that there is immediately formed a kind of paste, that is not very bulky; and this is to be put by in an earthen jar, or in a barrel, until it is filled, by repeating the same

same process, by which means all the roses will be equally salted in a proper manner. The vessel is then to be shut up, and kept in a cool place, until it is wanted. When it is desired, at any leisure time, to begin the distillation, this aromatic paste is to be put into the body of the still along with twice its weight of water. By this means there is no occasion to be hurried by the season, nor pay any attention to the distance, as a person at Paris may distil during the winter the aromatic vegetables that were salted a long time before in the provinces most distant from the capital.

According to some observers, the distilled waters obtained in this manner are much more agreeable than common, and nevertheless they yield more essential oil. It may, however, be affirmed, that these saltings may be applied to some very useful purposes; for example, if it be true that the distilled waters of some plants cannot be preserved from one year to another, notwithstanding they were prepared with every possible attention; it is equally certain, that these plants being well salted, need only be distilled when wanted, and may thus be used while all their medical virtues are in perfection.

## *On an artificial Stony Surface.*

*By* F. R. CURADAU.

From the JOURNAL DE PHYSIQUE.

THE artificial stones here described, offer a remarkable example of the great degree of solidification that water can acquire in certain combinations.

These stones, in the composition of which water forms more than half the weight, are composed besides of one part of sulphuric acid, and two parts of baked clay reduced to powder.

The simple mixture of these three substances, would only yield a solution of sulphate of alumine; but, when the reciprocal action of these substances is favoured, heat is speedily produced, and the emission is sometimes so considerable, that the matter appears to be ignited.

This extraordinary phenomenon lasts during more than an hour, if twenty-five or thirty hundred weight of materials are used. The most remarkable circumstance is, that if the mixture has no water added to it, at the time when the re-action of the substances upon one another is the strongest, the mass, although it be still liquid, suddenly acquires a great degree of solidity: the heat which it produces is augmented, and the substance afterwards becomes almost entirely insoluble.

This last property being acquired by a mixture destined to yield very soluble salts, proves that the penetration of the earth by the water and acid is very great, as the whole mass forms only a stony composition.

The stones here meant, although they have apparently all the properties of those just described, are not however insoluble. They were hindered from acquiring that

that state, as they would then be useless. But as this composition has, except insolubility, all the external characters of the hardest stones, this artificial stony substance possesses some attention on account of several properties which may render it useful. For example, after it has been softened by a degree of heat superior to that of boiling water, might it not be employed with much advantage as a cement, or to cast into statues, model vases, or many other uses that experience will point out? It is true, that bodies formed of this stone-paste must be protected from the influence of water or moisture.

Another consideration, which adds to the interest of this new stony composition is, that the theory of its formation, and its analogy with the stones of Solfaterra, will not require us to recur to the hypothesis of subterranean fires kept by combustible substances, in order to explain volcanic eruptions.

In effect, as water, by only passing in an instant from the liquid to a solid state, developes such a very considerable heat, may it not be the immediate cause of volcanic eruptions? Is it not also to the slow and successive passage of water to the solid state that the heat, which is kept up at great depths in the interior parts of the globe, is owing? Lastly, may not the heat developed in the vegetable and animal organs be also owing to water?

Such are the reflections arising from the observations of the object of the present notice: they are presented to chemists, natural philosophers, mineralists, physiologists, in the hope that the concurrence of the lights furnished by each of them, cannot but clear up a question that merits from mankind the most profound meditation.

*Report*

*Report made on a Method employed in the Mint (in Paris) to destroy the Smoke of Steam-Engines. Jan. 18, 1809.*

*By M.* GUYTON MORVEAU *and* DE PRONY.

From the ANNALES DE CHIMIE.

M. GUYTON de Morveau, and myself, have examined, by order of the class, the means employed by M. Gengembre to procure the combustion of the smoke of the steam-engine which turns the flatting mills of the mint at Paris; but before the success which M. Gengembre has obtained by its means is related, it will be proper to explain the manner in which it is performed.

The boiler of the steam-engine is a solid of revolution generated by a trapezium, which is terminated at the upper part by a semi-circle. The plan of the fireplace under the boiler is, of course, a circle, and the grate is a square inscribed in the circle.

The door by which fuel is introduced, at the extremity of one of the diameters of the fireplace, answers to an opening placed at the other extremity, of the same diameter, by which the flame escapes to circulate round the boiler, following a channel made in the brick-work round the sides. This channel terminates, after an entire revolution, in a chimney communicating with the external air.

Two other channels made in the brick-work, which are always open, are on the two sides of the door of the fireplace, and make each of them half a revolution, in opposite directions, below the channel of circulation that envelopes the boiler, in order that they may open on the two sides of that opening of the fireplace by which the flame enters into the channel that causes it to circulate round the boiler.

Upon

Upon this construction the two currents of air, introduced by the two channels just described, as soon as the door of the fireplace is closed, unite into a single one, which rushes along with the flame into the channel of circulation. The vaporized part of the fuel which is not yet consumed, and would produce the smoke, preserving, by this means, a temperature which is sufficiently high to separate the principles of the atmosphere and to unite with the oxygen, is burned before it arrives at the chimney, which only receives transparent gases. The caloric disengaged by the combustion of the smoke contributes to the heating of the boiler.

These effects take place during the whole of the time that the door of the fireplace is shut; but, as soon as it is opened, to introduce fresh fuel under the boiler, the combustion of the smoke immediately ceases.

We have profited of this slight inconvenience to completely assure ourselves of the efficacy of the process of M. Gengembre, by examining, from one of the courts of the mint, the top of the chimney belonging to the steam-engine. As soon as the door of the fireplace was opened a thick smoke rose up into the atmosphere, and disappeared as soon as this door was shut again. The effect was perfectly instantaneous.

Here then is a very simple and infallible method of freeing the habitations in the neighbourhood of steam-engines, from a grand inconveniency which makes them to be regarded as the scourge of the places where they are established. There still remains a slight inconvenience in the engine at the mint, whose fireplace was not intended for the combustion of the smoke, that of yielding it during the very short space of time of the introduction of fuel. But it will be very easy to avoid this incon-

inconveniency in future, by constructing the furnaces after the manner of those called athanors, in which the fuel is introduced and renewed by means of a slow Harry, so that the fireplace is constantly closed.

M. Gengembre does not claim the invention of the method of destroying smoke that is just now described. He expressly mentions in his note, that he knew, before he began, of the processes used for that purpose by Messrs. Clement and Desormes in the furnaces of their alum manufactory at Verbérie. But we cannot refuse him the merit of being the first among us who applied these methods to steam-engines.

The construction of smoke-destroying apparatus was formerly known in France. There may be found in the early volumes of the Academy of Sciences, before the definitive organization which took place in 1669, a description of one of these apparatus, which perfectly answers its purpose, and which had been presented by M. Dalesme, the author of many other discoveries, mentioned or described in the different collections of the Academy, and who appears to have been a very ingenious man, of great inventive powers. M. Dalesme placed the fireplace in the lower part of a reversed syphon, one branch of which being longer than the other, performed the office of a chimney. As soon as the internal part of this long branch was heated, a current formed by the air flowing out of the small branch was established, which drew down the flame of the fire, so as to make it pass under the grate, and thus the smoke was completely buried.

Delahire made some experiments, and inserted, in the volume for 1669, a note respecting the process of Dalesme, which is also described in Boerhaave's Treatise

tise on Chemistry, and was usefully employed, in the 17th century, in several manufactories.

His furnace is of the kind called furnaces with reversed flame. The same theory, which occasioned that construction, and explained its effects, will equally explain the construction and effects of the different smoke-destroying apparatus * lately conceived or brought forwards. It is well known that black visible smoke is formed of the volatilized parts of the fuel held suspended in the transparent gases which are formed by the combustion. The parts thus volatilized, are, as it were, lost to the fire, as well because the mass of air that yielded the oxygen was not in a proper proportion to the quantity of the fuel, as because this fuel was not sufficiently heated to decompose the air with which it was in contact. The recent progress which the theory and practice of the arts which depend upon chemistry have made in France, have furnished for some years past several important occasions of finding out the best method of fulfilling the conditions necessary for a complete combustion, free from any inconveniences, the principal of which are,

1. Such a disposition of the fire-place, that a current of air may be established, flowing through the door, or some opening into the pipe or chimney, by which the gases set free by the combustion, are allowed to escape. The theory that leads the builder to

* We here use the expression "smoke-destroying apparatus," in order to distinguish, without any equivocation, the inventions here mentioned, from those which are only intended to hinder stoves or chimnies from smoking; and which need only to satisfy the first condition afterwards mentioned, whereas the smoke-destroying apparatus must fulfil all those conditions.

this construction, being considered in a general and abstract manner, is reducible to that by which the phenomenon of Dalesme's syphon is explained, and its several applications depend upon the proportions which ought to be established between the two branches, their positions and forms, and on the size, form, and position of the opening which forms the communication between the long and short branch, &c.

2. The flowing upon the fuel of a mass of air in a proper proportion to the quantity of the fuel, in such a manner that the fuel shall find in the air which comes in contact with it such a quantity of oxygen, that all the molecules of the fuel which are capable of being combined with that constituent part of the air shall unite with it.

Experience shews, that in order to obtain this effect, a much greater quantity of air is required than contains the exact quantity of oxygen strictly necessary to the combustion, supposing that this oxygen was pure, or previously separated from the azote *. A sufficient elevation of the temperature at the place of contact of the air with the fuel, to cause the decomposition of the air.

Argand's

* M. Clement, profiting by the knowledge and experience of M. Montgolfier, in the art of calculating the effects of furnaces, of proportioning their dimensions, and of disposing the various parts of them, according to the uses to which the caloric is to be applied, has found by experience, that in practice it is necessary to bring near three times as much air in contact with the fuel as theory would indicate to be necessary for its perfect combustion.

For a chilliogramme (2 lb. averd.) of wood, about 10 chiliogrammes of air are required; for a chiliogramme of coal, 20 chiliogrammes of air, &c. which, supposing that the oxygen and azote that enter into the composition of atmospheric air, are in the proportion of 22 to 78, shews that wood requires 2,20 of its weight of oxygen,

Argand's lamps offer an application of these principles, which is as curious as it is useful. The rack which allows the wick to be lengthened or shortened, furnishes the means of always proportioning the mass of the burning body to that of the air which passes through and surrounds the flame. This proportion is so indispensible that as soon as it is altered, by uncovering too much of the wick, smoke is immediately produced. M. Clement speaks of a manufacturer of these lamps, who, in order to procure the means of uncovering more of the wick, and of course of producing more light but without smoke, had made several small holes in the glass chimney immediately above the groove in which it is placed, by which means additional threads of air flow upon the external surface of the flame. By thus augmenting the quantity of air to be decomposed, he is able to augment proportionally the surface of the wick impregnated with fuel.

oxygen, and coal 4.40 of its weight. In order to compare these quantities with those for combustion with pure oxygen, we must refer to the experiments of Lavoisier and Laplace, who found that 100 parts, by weight, of charcoal, consumed, during their combustion, 251 parts of pure oxygen; and that the caloric disengaged melted 9638 of ice. M. Clement concludes, from these data, that wood requires 0.83 of its weight of pure oxygen, and coal 1.66 of its weight, in order for their complete combustion, by deducing these quantities from the calorific values of the combustibles as estimated by the calorimeter, on the hypothesis that the quantity of the caloric disengaged is proportional to the quantity of oxygen that is used in the combustion. Now, the numbers 0.83 and 1.66 are rather more than 1-3rd of the numbers 2.20 and 4-40. M. Clement has verified these results in a direct manner, by examining the gases which escape at the top of the chimney, and which he found to be air retaining about 2-3rds of its oxygen.

The

The principles here explained are generally known by well-informed men who are engaged in manufactures, and the example of their application to Argand's lamps ought naturally to lead them to the idea of directing similar currents upon the flame of furnaces, by openings, or particular channels, which can never be stopped, in order to supply the insufficiency of the air that passes through the grate, where it is frequently stopped by the slags: another disposition still more analogous to these lamps, consists in causing the smoke to pass through a narrow throat, which, from its small surface, and the heat of its sides, would not lower its temperature in any sensible degree, and to which place a continual current of air not disoxygenised may be brought by means of other tubes or channels. Thus the two conditions necessary to combustion, namely, oxygen and a certain temperature, would be united in the current of the smoke, and the combustible materials which are suspended in this smoke would of course be burned.

Messrs. Clement and Desormes being equally versed in the knowledge of natural philosophy, and in the arts, have put in practice, seven or eight years ago, some dispositions of the first sort in a manufactory of green vitriol, established at Paris, near de la Garre, and have made others of the same kind in their manufactories of alum at Verberie. Their connection with M. Montgolfier, a member of this class, had enabled them to assist their conceptions with those of our fellow member. But they have not been the first who have availed themselves of so good a help. It is now two years since M. Champy, junior, who was thinking on the same subject for his furnace at the gunpowder works at Essone, had consulted

consulted with Messrs. Montgolfier, and Clement, and afterwards built, without having seen the establishments of de la Garre and Verberie, smoke-destroying furnaces for the drying houses of the gunpowder works at Essone, with the greatest success.

The constructions of M. Gengembre, of which we have given an account to the class, are, as we have already said, and as he says himself, the result of the knowledge acquired by the labours of Messrs. Clement, Desormes, and Champy. These gentlemen have declared, that when they began to occupy themselves about methods of destroying smoke, they did not know of the inventions of Messrs. Roberton and Watt, of which we shall now speak, and we do not hesitate to give credit to their declaration.

It was in 1801, a short time before the first trials of Messrs. Clement and Desormes, that Messrs. Roberton of Glasgow, in Scotland, took out a patent for smoke-destroying furnaces. Their process consisted in introducing, immediately over the fire-place, a plate of the external air, the thickness of which may be altered by means of a very simple mechanism, which regulates the distances of two inclined plates of iron between which this plate of air passes. The space between these two plates communicates with the atmosphere by a horizontal opening made above the door, and against which the plates are placed.

Our fellow member, M. Pictet, saw at London a small steam-engine, furnished with this apparatus, of which he has given a description in the Bibliotheque Britannique for 1782, and which perfectly answered the purpose. The late Mr. O'Reilley has since described the

same

same apparatus in the Annales des Arts et Manufactures.

It was known, on the other hand, by hearsay, that our fellow member, Mr. Watt, had long before the date of Messrs. Roberton's patent occupied himself on the means of burning the smoke from steam-engines. But we do not believe that he has published his inventions on that head. At least there is no mention of them in any of the works which give an account of the English inventions that have come to our knowledge *, and as Messrs. Watt and Bolton, who shew with a great deal of complaisance and politeness the working and uses of their engines, are very careful to conceal their internal construction, we should not have had any idea of their method of destroying the smoke, if they had not adapted the apparatus to a steam-engine at Nantes, the several parts of which were got up in their workshops, and which was erected at Nantes in the year 1790, under the direction of our fellow member M. Levêque, who had discussed and arranged the plans with Mr. Watt himself. This apparatus is very similar to that of Mr. Roberton. The principal difference is, that in Watt's engine the current of air is introduced under the grate instead of above it, as in Roberton's engine. The first apparatus is therefore with a direct flame, and the second with a reversed flame. Our fellow member M. Levêque has assured us that the engine at Nantes does not yield any smoke.

* See the various volumes of this work.

*** *No Patents passed the Great Seal during the month of October.*

THE

# REPERTORY

OF

# ARTS, MANUFACTURES,

AND

# AGRICULTURE.

No. XCII. SECOND SERIES. Jan. 1810.

*Specification of the Patent granted to* FREDERICK BARTHOLOMEW FÖLSCH, *of Oxford-street, in the Parish of Saint James Westminster, in the County of Middlesex, Merchant; for several Improvements on certain Machines, Instruments, and Pens, calculated to promote Facility in Writing.* Dated May 9, 1809.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Frederick Bartholomew Fölsch do hereby describe and ascertain the nature of my said invention and improvements in manner following; that is to say: First; in having a valve acting with a spiral spring, or a screw to affix on the tube of the pen, to supply it occasionally with air to force the ink into the socket of the pen. Secondly; in having a small pipe at the bottom of the tube to convey the ink into the socket of the pen through which it is forced by the operation of the valve

at the top of the tube. Thirdly; in having a plate on front of the socket of the pen to contain a supply of ink for the nib, and to prevent the ink flowing too freely into the nib.

The drawings or plan in the margin of these presents, and the following description thereof, with the marks of reference, will convey a more perfect knowledge of the separate parts, and in what manner the same is to be performed.

Figure A (see Plate IV.) is a section of a pen, which may be made of any sort of metal consisting of three parts, which may be joined together by screws or socket joints. No. 1 at the top I call the box, No. 2 the tube, and No. 3 the socket; it is made in three divisions, for the purpose of cleaning the pen in case it should get foul, and to supply the tube with ink, and to affix any of the different sockets to the tube at pleasure. The box No. 1 has a bottom soldered in, having a hole in it to admit air to pass into the tube through the top of the box; it contains a spiral spring: a small rod at *a*, having a plate or valve *b* at the bottom of it covered with leather, passes through the hole at the bottom of the box, but is not so thick as to fill the hole, and the rod *a* screws into the nob *c*, and confines the spring within the box: the spring pressing upwards against the nob *c* keeps the plate or valve *b* close to the bottom of the box, to prevent the ink getting out of the top. The tube No. 2 has a bottom soldered in at *a*, above the joint that unites it with the socket: in the bottom is a small pipe or tube *e*, for the ink to pass through into the socket. The socket No. 3 is hollow, and has a hole in the front, at *f*, to admit the air, and to adjust the quantity of ink it will bear: the lower part or cradle *g* is made in the shape of a common

common pen, with a slit up the nib: the cradle or sloping part *g* has a plate soldered on the front of it: the lower end of the plate is fitted nearly close to the inner part or hollow of the nib, but left loose and in a slanting direction towards the point and below the top of the slit up the nib, so that in writing the nib bending it lets the ink pass freely, but not too copiously, to the point of the nib. The profile of the plate is shewn at *g*, in figure A; and the front view of the same plate at *g* in figure B, which is a front view of the pen as complete. The lower part of the plate in some of my pens is made in a separate part, and fits into the socket by means of a groove, the more readily to clean the inside of the nib: the profile and front view of the plate is shewn in the figure C. The tube part of the pen being filled with ink, and the box and the socket put on, press the nib *c* down, the air will pass through the hole at the bottom of the box upon the surface of the ink, and cause it to flow through the pipe *e* into the socket: the separate parts of the pen are shewn on a larger scale by the auxiliary drawings having the same marks of reference. Figure D is a front view, and figure E is a section, on a large scale, of a different kind of socket to affix to the tube of the same pen; the lower end is made angular, with a plate to the front of it, soldered and fitted nearly close to it, and also a loose plate in some pens like unto the socket No. 3, figure C. The nib has no slit, but a small notch or groove at the end, as shewn at *h*, figure D, with a hole *i*, in the plate *g*, to admit air: this pen you write with the back or angular part towards you. Figure F is a section, on a large scale, of a tube which may be used without a box or spring, the nob or top *c* screwing on the tube, and having a hole made within the

screw part of it, shewn by the black line at *d*, will admit air into the tube by unscrewing the nob a little, which will answer the same purpose as the box and spring.

In addition to the improvements above described, a part of my said invention consists in filing or cutting the socket of the pen, for which I obtained a patent in the month of March last *, hollow in shape like the nib of a pen, and making a small groove at the point instead of a slit. Figure G is a front view, and figure H is a section, on a large scale, of the last-mentioned socket: the point *k* is tapered on the outside like the point of a pencil with the front cut hollow, in shape like the nib of a pen, and a small groove is made up the nib at *k* instead of a slit, which guides the ink to a point.

In witness whereof, &c.

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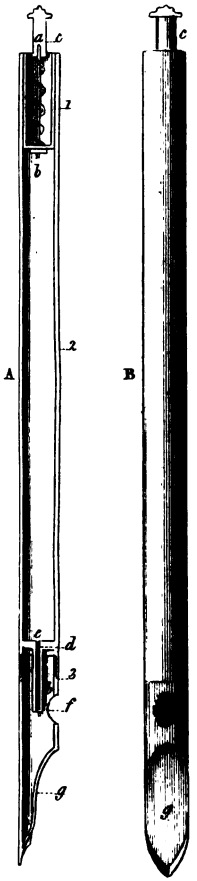
*Specification of the Patent granted to* JOHN DAVENPORT, *of Longport, in the Parish of Burslem, in the County of Stafford, Glass-maker; for a Method of ornamenting all Kinds of Glass in Imitation of Engraving or Etching, by Means of which Borders, Cyphers, Coats of Arms, Drawings, and the most elabbrate Desighs may be executed in a Style of Elegance hitherto unknown, and which cannot possibly be equalled by the usual and customary Mode of Etching or Engraving as hitherto practised.* Dated July 6, 1806.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Davenport do hereby declare that my said invention is by coating, and afterwards etching,

* See the specification inserted in our preceding volume.

engraving,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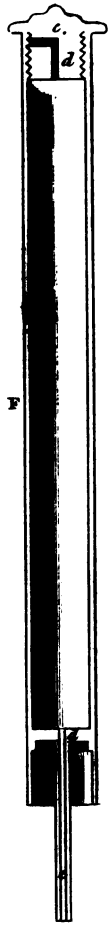
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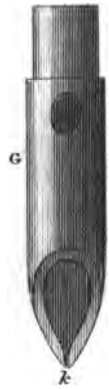
G
k

H

engraving, and chasing on the glass so coated; and the manner in which the same is to be performed, is described and ascertained as follows. The method heretofore used for engraving and designing borders, &c. on glass has been by means of a machine with wheels of different substances, which have been employed with a sharp stone or sand to grind off some parts of the surface of the glass which is to be engraved upon, and then, by means of grinding and polishing different parts on the rough surface, the different borders, figure, &c. &c. are formed according to the designs given, or at the will of the operator. And the usual method of grinding window-glass, for the purpose of making blind windows, has been by means of a machine moving on the surface of the glass in contact with sand or a sharp stone, or the like substances applied by the hand, thereby grinding off the polished surface, leaving the glass sufficiently opake to prevent any objects being clearly distinguished through it, and yet affording sufficient light for common purposes. Now the present invention and object of this patent, instead of grinding or taking off any part of the surface of the glass as aforesaid, is to lay on an additional surface or coating of glass, prepared for that purpose, which, when subjected to a proper degree of heat, will incorporate with the surface of the glass operated upon so as to produce an effect similar to that which has heretofore been obtained by means of grinding as aforementioned. And when it is required that the glass should be ornamented with any borders, cyphers or designs, &c. then, previous to the heat being applied, with an etching or engraving, or a chasing tool, or any other pointed instrument, of metal, bone, wood, or any other hard substance, to etch out, engrave, chase,

or

or work out such parts of the surface or coating so laid out as will produce an effect similar, but greatly superior, to the effect heretofore produced by the usual mode of grinding and polishing with wheels as before mentioned; and the method I use is as follows. When I want to prepare the glass for coating, I take one or more of the smallest pots in the furnace, called by the glass-makers pile end pots; or I take any small or large pot or crucible for the purpose, according to the quantity wanted, which I fill in the usual mode, with a batch or batches of materials, made up in the same manner as it is used for the making of best flint glass, the article of broken glass, or what the glass-makers term cullitt, being the principal ingredient therein; and the proportions I have used with most advantage are as follows: For mixture No. 1, for 160 parts of cullitt or broken glass take 10 parts of pearl ashes, 40 parts red lead, and 10 parts of arsenic. For mixture No. 2, for 120 parts of cullitt or broken glass, 160 parts of red lead, 60 parts of sand or siliceous earth, and 60 parts of borax. For mixture No. 3, 70 parts of red lead, 22½ parts of sand or siliceous earth, and 40 parts of calcined borax. When the above mixtures have been subjected to a degree of heat in the furnace sufficient to obtain a complete fusion or vitrification of the substances employed, I then take of each mixture, in equal parts, the quantity which is to be ground and levigated into an impalpable powder, and to be mixed with a menstruum proper for coating the glass, as hereafter described. In those works in which the glass-makers use litharge instead of red lead, it may be substituted in the above mixtures in lieu thereof; and other proportions of the above ingredients, or others of a like quality, will

will produce nearly a similar effect, or they may be compounded in one or more mixtures instead of three, but the most beautiful specimens were produced by the combinations above specified.

I do not claim any exclusive right by this patent for the making of this glass but for the invention of applying it to coat the surface of other glass, and for operating upon it in a manner entirely new, as herein described, and for producing by these means an effect superior and different to any thing heretofore produced. This glass may be levigated in any of the usual modes, taking care that no injurious substance is introduced, and that the utmost degree of fineness is obtained which the powder is capable of; and for this purpose I prefer using a small mill with a pan, the bottom and sides of which are strong glass, with a grinder or levigator, cast also of solid glass, to work therein.

When the glass is sufficiently levigated it may be mixed with the menstruum hereafter described, either in a wet state or as it comes from the mill, or it may be dried into the state of powder, as most convenient.

To prepare the menstruum which I use for the purpose of mixing with, and for laying on the ground glass, I take one part of double-refined loaf sugar, dissolved in two parts of pure water, to which is added, at the time of mixing up the powder, about one-third part of common writing ink, the component parts of which are universally known, or of a watery solution of calcined copperas; the effect produced by the addition of either of these latter substances I take to be similar to that which is produced by the addition of oxyd of manganese, used in a small quantity by the glass-makers in making their best flint-glass, because without such addition

dition I have found the specimens had more of a cloudy or milky appearance somewhat similar to what is termed by the workmen in the glass-house shappy metal, and which quality and appearance it is understood the addition of the above-mentioned oxyd tends to eradicate and destroy. The oxyd of manganese, or possibly other oxyds, may produce the same effect here; but the above specified substances, or either of them, are sufficiently cheap to warrant their general use, and I have found them to answer every purpose required. Of the above compound menstruum I then add, in manner aforesaid, a quantity sufficient to render the ground mixture or powder of a proper consistence for laying on with a very thin and even surface, and which necessary quantity and consistency, as well as the necessary thickness of the coating to be laid on, the operator will soon and easily ascertain; and as in the course of working or laying on the mixture some of the watery particles will evaporate, he will add, as occasion requires, the necessary quantity of the solution of sugar for the purposes aforesaid. The advantages which I have found in the discovery of the use of this simple mixture of sugar and water is, that whenever I have made use of any of the essential oils, gums, resins, and many other substances which have been tried, the coating became set so fast on the surface that the workmen could with difficulty proceed, and the delicate parts of the designs could not be etched out with that nicety and precision required; whereas the above menstruum rendered the coating sufficiently fast to prevent the surface from being rubbed off while the work was under hand; and when the workman wished to operate on any particular part of the surface, he had only to breathe upon that part, by which

means

means the menstruum imbibes moisture from his breath, and the mixture becomes soft and pliable to his tool, while those parts not breathed upon remain fast as before: there may be other substances which might produce the effect, and answer the purpose of the above menstruum, but I have found this to possess all the advantages required.

When the coating or mixture is prepared as aforesaid, I then proceed to coat the surface of the glass to be operated upon by means of brushes of squirrel's or camel's hair, or any fine animal hair, or any other substance which is capable of laying it on with a very thin and even surface; and the most convenient form for that purpose is to have the points of the hair and other substances spread out, and so disposed as to form a crescent or segment of a circle, the size according with the size and nature of the work to be performed. After this coating has been applied evenly over the surface of the glass, and if no parts thereof are intended to be polished or worked out, the glass is then exposed to a heat sufficient to produce a semivitrification of the coated surface, and to incorporate it sufficiently with the substance or body of glass so coated, but great care must be had not to extend the degree of heat farther than is necessary for these purposes, because in that case a complete vitrification of the coating would ensue, whereby the desired effect of having a surface in imitation of the rough surface produced by grinding would not be obtained. And although when this happens the article may be re-coated and again submitted to the fire, the loss of labour would be considerable thereon, but which, by a proper attention to the necessary degree of heat, may be easily avoided; and if, after this

coating has been applied, any borders, cyphers, coats of arms, or other ornamental designs are wanted to be executed thereon, then, previous to the heat being applied, with an etching or engraving or chasing tool, or any other pointed instrument of metal, bone, wood or any other hard substance, I work out, etch or engrave and chase out, such part or parts of the coated surface so laid on as will produce the desired effect. After which I subject the article or articles to the requisite degree of heat as before mentioned.

This invention is not only applicable to all kinds of useful and ornamental articles of glass ware whereon the common methods of engraving have been practised, but may be applied to window-glass and plate glass of every description, in place of grinding as aforesaid, for the purpose of making blind windows. And the method of etching, engraving and chasing thereon, is peculiarly adapted to produce beautiful specimens of art for the windows of altar-pieces, libraries, museums, coach-windows, ornamental buildings of all descriptions, and all other purposes wherein plate-glass and window-glass has been commonly used.

This invention has also an advantage over the common method, by the work wearing much cleaner than the work of ground-glass. The surface of which being somewhat fractured by the action of the wheel, &c. is therefore liable to gather dirt on the rough unpolished parts of the borders or designs so executed, a fault which has been very much complained of.

In witness whereof, &c.

*Specification*

*Specification of the Patent granted to* JOHN LEIGH BRADBURY, *of Navan, in the County of Meath, Cotton-spinner; for a Method of spinning Cotton, Flax, and Wool.* Dated December 24, 1807.

With an Engraving.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Leigh Bradbury do hereby describe and ascertain the nature of my said invention, and in what manner the same is to be performed by the plan or drawing in the margin of these presents, and the following description thereof; that is to say: the fly A, Fig. I, (Plate V), in the annexed figure, turns upon the spindle B, with its arms pointing upwards. The bottom of the spindle rests upon, and turns in, the step C, fixed in the rail D, and passes through the collar in the rail E, which supports the fly resting on the washer F; the upper part of the spindle is smaller in diameter, the length of the bobbin G, so as to leave a shoulder for it to rest on; H is a wharve, or pulley, fixed on the spindle; and I is another wharve, fixed on the socket of the fly. The fly A, turned by the wharve I, from the drum K, twists the thread as delivered from the rollers of the machine, and by means of the thread turns the bobbin G. The draught, or winding up of the thread on the bobbin, arises from the friction of the inside of the bobbin against the small part in the spindle, and from the bottom of the bobbin against the shoulder of the spindle, or washer M fixed thereon. This draught is regulated by the spindle which is turned by the wharve H, from the drum L, in the same

direction as the fly in a contrary direction, or remains stationary, as the quality of the thread requires. The figure is represented in a perpendicular position, as being preferable to an horizontal, or oblique, one. The traverse is obtained by the rising and falling of the rail supporting the fly, or the one supporting the spindle. On account of the distance they are from the cylinder, or drums K and L, the band will not fall off the wharves H and I. The principle of this improvement, as distinct from the old mode, consists in inverting the fly, and giving it a separate motion from the spindle. The improvement arises chiefly from the following particulars; first, as the fly is the chief agent in twisting the thread, it is the only part kept in rapid motion; consequently, there is a great saving of power, since, in the old machine, the spindle and fly turned together at the same speed. Secondly, the bobbin, fly and spindle, having their distinct and separate motions, the draught or inclination of the thread to wind up can be regulated to the utmost exactness, and, when regulated, will remain invariably the same at whatever speed the machine shall turn; whereas, in the old mode, a variation of speed produces a variation of draught, thereby breaking the thread, and causing much waste. Thirdly, on account of the inverted position of the fly, the bobbin can be taken off, and put on with expedition; whilst, in the old plan, it was necessary to stop the spindle, and unscrew the fly from the top, or to take out the spindle. By these improvements the quantity of yarn produced by each spindle is nearly double to that of the old plan with the same power, and of any degree of fineness required.

In witness whereof, &c.

*Method*

Fig. 1.

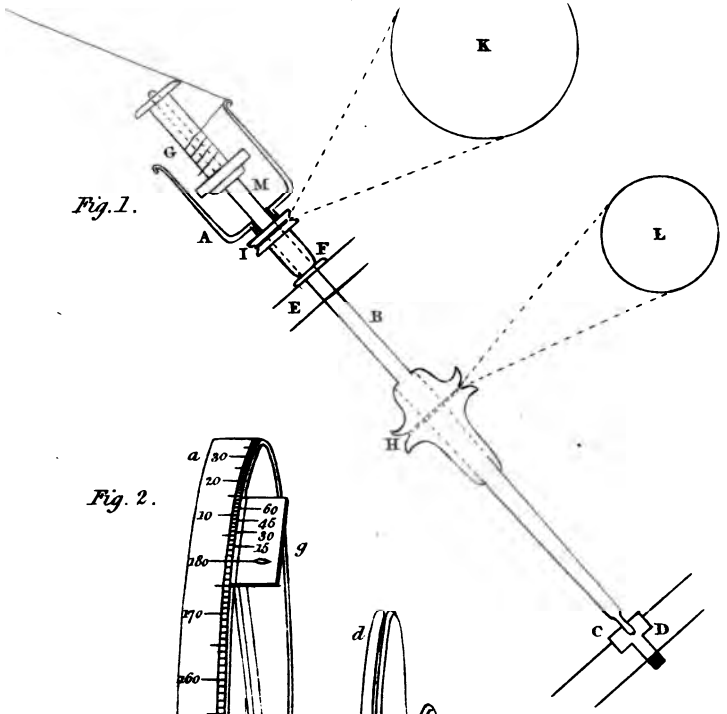
K
G
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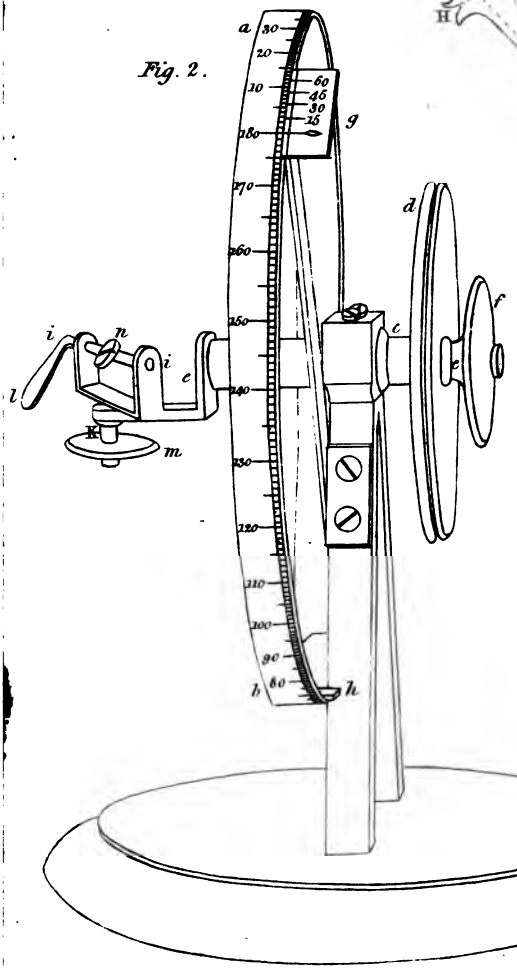
Fig. 2.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m

*Method of dividing Astronomical and other Instruments, by ocular Inspection; in which the usual Tools for graduating are not employed; the whole Operation being so contrived, that no Error can occur but what is chargeable to Vision, when assisted by the best optical Means of viewing and measuring minute Quantities.*

*By Mr.* EDWARD TROUGHTON.

(Concluded from Page 36.)

With a Plate.

HAVING now completed the two first sections of my method of dividing; namely, the first, which consists of making 256 small round dots; and the second, in finding the errors of those dots, and forming them into a table; I come now to the third and last part, which consists in using the erroneous dots in comparison with the tabulated errors, so as ultimately to make from them the true divisions.

It will here be necessary to complete the description of the remaining part of the apparatus. And first, a little instrument which I denominate a subdividing sector presents itself to notice. From all that has hitherto been said, it must have been supposed that the roller itself will point out, upon the limb of the instrument to be divided, spaces corresponding to others previously divided upon itself, as was done in setting off the 256 points: but, to obviate the difficulty of dividing the roller with sufficient exactness, recourse was had to this sector; which also serves the equally important purpose of reducing the bisectional points to the usual division of the circle. This sector is represented in half dimensions by Fig. 5: it is formed of thin brass, and centred upon

upon the axis at A, in contact with the upper surface of the roller: it is capable of being moved round by hand; but, by its friction upon the axis and its pressure upon the roller, it is sufficiently prevented from being disturbed by accident. An internal frame B B, to which the arc C C is attached, moves freely in the outer one, and by a spring D is pushed outwards, while the screw E, whose point touches the frame B, confines the arc to its proper radius. The arc of this sector is of about four times greater radius than the roller, and upon it are divided the spaces which must be transferred to the instrument, as represented on a magnified scale by Fig. 4. Now, the angle of one of the spaces of the circle will be measured by sixteen times its angular value upon the sectorial arc, or 22° 30′; but this does not represent any number of equal parts upon the instrument, whose subdivisions are to be 5′ each; for $\frac{1024'22''5}{5}$ is exactly 16¼, therefore so many divisions are exactly equal to a mean space between the dots whose errors have been tabulated. Let, therefore, the arc of the sector be divided into 16 spaces of 1° 20′ each, and let a similar space at each end be subdivided into eight parts of 10′ each, as in Fig. 4: we shall then have a scale which furnishes the means for making the true divisions, and an immediate examination at every bisectional point.

I have always divided the sector from the engine, because that is the readiest method, and inferior to none in point of accuracy, where the radius is very short; but, as it is more liable than any other to centrical error, the adjustment of the arc by the screw E becomes necessary: by that adjustment, also, any undue run in the

the action of the roller may be reduced to an insensible quantity *.

When the utmost degree of accuracy is required, I give the preference to dividing by lines, because they are made with a less forcible effort than dots are; and also because, if any small defect in the contexture of the metal causes the cutter to deviate, it will, after passing the defective part, proceed again in its proper course, and a partial crookedness in the line will be the only consequence; whereas a dot, under similar circumstances, would be altogether displaced. But, on the other hand, where accuracy has been out of the question, and only neatness required, I have used dots; and I have done so, because I know that when a dot and the wire which is to bisect it are in due proportion to each other, (the wire covering about two-thirds of the dot,) the nicest comparison possible may be obtained. It may be farther observed, that division by lines is complete in itself; whereas that by dots requires lines to distinguish their value.

On the upper side of Fig. 1 is represented the apparatus for cutting the divisions. It consists of three pieces J K L, jointed together so as to give to the cutter an easy motion for drawing lines directly radiating from the centre, but inflexible with respect to lateral pressure; *d d* are its handles. The cutting point is hidden below the microscope H; it is of a conical form, and were it used as a dotting point, it would make a puncture of an elliptical shape, whose longer diameter would point towards the centre. This beautiful contrivance, now well known, we owe to the ingenuity of the late Mr. Hindley

* See note page 26.

of

of York; it was borrowed by Mr. Ramsden *, and applied with the best effect to his dividing engine.

It might have been mentioned sooner, that in the instance which I have selected as an example of my dividing, the operation took place when the season of the year, and the smoke of London, had reduced the day to scarcely six hours of effective light; and rather than confine my labours within such narrow limits, I determined to shut out the day-light altogether. Fig. 7 shews the construction of the lanterns which I used. A very small wick gave sufficient light, when kept from diverging by a convex lens; while the inclining nossel was directed down exactly upon the part looked at, and the light, having also passed through a thin slice of ivory, was divested of all glare. I enter into this description, because I think I never saw my work better, nor entirely to so much advantage as in this instance; owing, perhaps to the surrounding darkness allowing the pupil of the eye to keep itself more expanded, than when indirect rays are suffered to enter it. The heat from a pair of these lanterns was very inconsiderable, and chiefly conducted along with the smoke up the reeking chimney.

Previous to cutting the divisions, the parts now described must be adjusted. The cutting apparatus must be placed with the dividing point exactly at the place where the first line is intended to be drawn, and clamped, so that the adjusting screw may be able to run it through a whole interval. The microscope H must be firmly fixed by its two pillars *b b* to the main frame, with its micrometer head at *zero*; and with its only wire in the line of the

* This I learned from that most accurate artist Mr. John Stancliffe, who was himself apprentice to Hindley.

radius,

radius, bisecting the first of the 256 dots. And it should be observed, that the cutting frame and this must not vary respecting each other, during the time that the divisions are cut; for any motion that took place in either would go undiminished to the account of error. The microscope I is also fastened to the main frame; but it is only required to keep its position unvaried, while the divisions of the sector pass once under its notice; for it must have its wires adjusted afresh to these divisions at every distinct course. The microscope I has two wires, crossing each other at an angle of about 40°; and these are to be placed so as to make equal angles with the divisions of the sector, which are not dots, but lines. The sectorial arc must also be adjusted to its proper radius by the screw E, Fig. 5; so that while the main frame has been carried along the circle through a mean interval shewn by H, the sector must have moved through exactly 16; of its divisions, as indicated by I*.

Things being in this position; after having given the parts time to settle, and having also sufficiently proved the permanence of the micrometer H and the cutting frame with respect to each other, the first division may

* For the sake of simplicity, the account of the process is carried on as if the roller measured the mean interval without error: but it was said (page 18) that the roller, in a continued motion quite round the circle, would in some part of its course err by 30″ or more; therefore, when that is the case, an extreme run of the roller cannot agree with a mean interval of the circle nearer than $\frac{30''}{128} = 0'',23$; and most probably this kind of error will on some intervals amount to double that quantity. It therefore becomes matter of prudent precaution to examine every interval previous to making the divisions; and, where necessary, to adjust the sector, so that its arc may exactly measure the corresponding interval as corrected by the tabulated errors.

be made; then, by means of the screw for slow motion, carry the apparatus forward, until the next line upon the sector comes to the cross wires of I; you then cut another division, and thus proceed until the 16th division is cut, = 1° 20′: Now the apparatus wants to be carried further, to the amount of ¼ of a division, before an interval is complete; but at this last point no division is to be made; we are here only to compare the division on the sector with the corresponding dot upon the instrument: This interval, however, upon the circle will not be exactly measured by the corresponding line of the sector, which has been adjusted to the mean interval, for the situation of the dot 1°,4 is too far back, as appears by the table of real errors, by — 4,8 divisions of the micrometer head. The range of the screw for slow motion must now be restored, the cross wires of H set back to —4,8 divisions, and the sector moved back by hand, but not to the division 0 where it began before; for, as it left off in the first interval at ¼ of a division, it has to go forwards ¼ more before it will arrive at the spot where the 17th division of the instrument 1° 25′ is to be made, so that in this second course it must begin at ¼ short of 0: Go through this interval as before, making a division upon the circle at every one of the 16 great divisions of the sector; and H should now reach the third dot, allowing for a tabular error of — 10,2 when the division of ⅛ths of the sector reaches the cross wires of I. It would be tedious to lead the reader through all the variety of the sector, which consists of eight courses; and it may be sufficient to observe, that at the commencement of every course, it must be put back to the same fraction of a division which terminated its former one; and that the wire of the micrometer H must always be

be set to the tabular error belonging to every dot, when we end one interval and begin another. The eight courses of the sector will have carried us through $\frac{1}{45}$ part of the circle, 11° 1′5″, and during this time the roller will have proceeded through half a revolution; for its close contact with the limb of the circle does not allow it to return with the sector when the latter is set back at every course. Having in this manner proceeded from one interval to another, through the whole circle, the micrometer at last will be found with its wire, at zero, on the dot from which it set out; and the sector, with its 16th division, coinciding with the wires of its microscope.

Having now given a faithful detail of every part of the process of dividing this circle, I wish to remind the reader that, by verification and correction at every interval, any erroneous action of the roller is prevented from extending its influence to any distant interval. It will be farther observed, that the subdividing sector magnifies the work; that by means of its adjustable arc, it makes the run of the roller measure its corresponding intervals upon the circle; and, without foreign aid, furnishes the means of reducing the bisectional intervals to the usual division of the circle. Furthermore, the motion of the wire of the micrometer H, according to the divisions of its head and corresponding table of errors, furnishes the means of prosecuting the work with nearly the same certainty of success, as could have happened, had the 256 points been (which in practice is quite impossible) in their true places.

Now, the whole of my method of dividing being performed by taking short measures with instruments which cannot themselves err in any sensible degree, and, inas-

much as those measures are taken, not by the hand, but by vision, and the whole performed by only looking at the work, the eye must be charged with all the errors that are committed until we come to cut the divisions; and, as in this last operation the hand has no more to do than to guide an apparatus so perfect in itself, that it cannot be easily made to deviate from its proper course, I would wish to distinguish it from the other methods by denominating it, *dividing by the eye* *.

The

* I must here remark, that Smeaton has represented the greatest degree of accuracy that can be derived from vision, in judging of the coincidence of two lines at $\frac{1}{4000}$ part of an inch. From this it may fairly be inferred, that he had not cultivated the power of the sight, as he had done that of the touch; the latter of which, with that ability which appeared in all his works, he rendered sensible to the $\frac{1}{20000}$ part of an inch. Were materials infinitely hard, no bounds could be set to the precision of contact; but taking things as they are, the different degrees of hardness in matter may be considered as a kind of magnifying power to the touch, which may not unaptly be compared with the assistance which the eye receives from glasses. It is now quite common to divide the seaman's sextant to 10″, and a good eye will estimate the half of it; which, on an eight inch radius is scarcely $\frac{1}{10000}$ of an inch. This quantity, small as it is, is rendered visible by a glass of one inch focal length; and such is the certainty with which these quantities are seen, that a seaman will sometimes complain that two pair of these lines will coincide at the same time; and that may happen, and yet no division of his instrument err, by more than $\frac{1}{20000}$ part of an inch. All this is applicable to judging of the coincidence of *lines* with each other, and furnishes not the most favourable display of the accuracy of vision. But with the microscopes here described, where the wire bisects the image of a dot, or a cross wire is made to intersect the image of a line, by an eye practised in such matters, a coincidence may undoubtedly be ascertained to $\frac{1}{10000}$ part of an inch. I am of opinion, that as small a quantity may be rendered visible to the eye as can by contact be made

The number of persons at all capable of dividing originally has hitherto been very few; the practice of it being so limited, that, in less than twice seven years, a man could hardly hope to become a workman in this most difficult art. How far I shall be considered as having surmounted these difficulties, I know not; but if, by the method here revealed, I have not rendered original dividing almost equally easy with what copying was before, I have spent much labour, time, and thought in vain. I have no doubt, indeed, that any careful workman who can divide in common, and has the ability to construct an astronomical instrument, will, by following the steps here marked out, be able to divide it, the first time he tries, better than the most experienced workman, by any former method.

If, instead of subdividing with the roller, the same thing be performed with the screw, it will not give to dividing by the eye any very distinctive character: I have practised this on arcs of circles with success, the edge being slightly racked, the screw carrying forward an index with the requisite apparatus, and having a divided micrometer head; the latter answers to the subdividing sector, and, being used with a corresponding table of errors, forms the means of correcting the primitive points; but the roller furnishes a more delicate action, and is by far more satisfactory and expeditious.

It is known to many that the six feet circle, which I am now at work upon for our Royal Observatory, is to be divided upon a broad edge, or upon a surface at right angles

made sensible to the touch; but whether Mr. Smeaton's $\frac{1}{100}$ and my $\frac{1}{1000}$ be not the same thing, I will not determine; the difference between them, however, is what he would no more have pretended to feel than I dare pretend to see.

angles to the usual plane of division: the only alterations which will on that account be required, are, that the roller must act upon that plane which is usually divided upon; which roller, being elevated or depressed, may be adjusted to the commensurate radius without being made conical, as was necessary in the other case. The apparatus, similar to the other, must here be fixed immoveable to the frame which supports the circle; its position must be at the vertex, where also I must have my station; and the instrument itself must be turned around its axis, in its proper vertical position, as the work proceeds. The above may suffice, for the present, to gratify those who feel themselves interested upon a subject which will be better understood, if I should hereafter have the honour of laying before the Royal Society a particular description of the instrument here alluded to; a task which I mean to undertake, when, after being fixed in the place designed for it, which I hope will be effected at no very distant period, it shall be found completely to answer the purposes intended.

Should it be required to divide a circle according to the centesimal division of the quadrant, as now recommended and used in France, we shall have no difficulty. The 100° of the quadrant may be conveniently subdivided into 10 each, making 4000 divisions in the whole round. The 256 bisectional intervals, the two tables of errors, and the manner of proceeding and acting upon them, will be exactly the same as before, until we come to cut the divisions; and for this purpose we must have another line divided upon the sector. For $\frac{1}{4000}$ part of the circle being equal to 5′,4 of the usual angular measure $\frac{1024'22'',5}{5',4} = 15\frac{1}{5}$ divisions; and just so many will be equi-

valent

valent to one of the intervals of the circle. The value of one of the great divisions of the sector will be 1° 26′ 24″, and that of the $\frac{1}{4}$ parts, which are to be annexed to the right and left as before, will be 10′ 48″, therefore divisible by the engine. Should any astronomer choose to have both graduations upon his instrument, the additional cost would be a mere trifle, provided both were done at the same time.

It must already have been anticipated, that dividing by the eye is equally applicable to straight lines as it is to circles. An apparatus for this purpose should consist of a bar of brass, three quarters of an inch thick, and not less than three inches broad; six feet may do very well for the length; it may be laid upon a deal plank strengthened by another plank screwed edgewise on its lower surface. The bar should be planed, on both its edges and on its surface, with the greatest exactness; and it will be better, if it has a narrow slip of silver, inlaid through its whole length, for receiving the dots. An apparatus nearly similar to the other should slide along its surface, carrying a roller, whose circumference is 12,8 inches, and turned a little conical for the sake of adjustment. The roller may be divided into 32 parts, each of which when transferred to the bar will give intervals of 0,4 of an inch each: the angle of the subdividing sector should of course be 11° 15′, and subdivided into four parts, which will divide the inch into tenths: the surface may also receive other lines, with subdivisions suited to the different purposes for which it may be wanted. The revolutions of the roller and its $\frac{1}{4}$ parts must be dotted upon the bar; taking care, by sizing the roller, to come as near the true standard measure as possible: when this is done, compare the extent

extent of the greater bisectional number that is contained in the length; i. e. 128 intervals or 51,2 inches, with the standard measure; noting the difference as indicated by the micrometer heads: the examination and construction of the table of errors may then be conducted just as was done for the circle.

Being now ready for the performance of its work, the scale to be divided must be laid alongside of the bar, and the true divisions must be cut upon it by an appeal, as before, to the erroneous dots on the bar, corrected by a corresponding table of errors. The apparatus, remaining entire in the possession of the workman, with its primitive dots, the table of errors, &c. is ready for dividing another standard, which will be precisely similar to others that have been, or may be, divided from it. It may be considered, indeed, as a kind of engine; and, as it is not vitiated by the coarse operation of racking with a screw, but performed by only looking at the work, the method will command about three times the accuracy that can be derived from the usual straight-line dividing engine. Should it be asked, if an engine thus appointed would succeed for dividing circles? I answer, Yes; but I would not recommend it; because, beyond a certain extent of radius, it is not necessary; for the errors, which would be introduced into the work by the violence of racking a large wheel, are sufficiently reduced by the comparative shortness of the radius of such instruments as we divide by that method: and, what is still more to the purpose, the dividing engine is four times more expeditious, and bears rough usage better. I cannot quit the subject of dividing straight lines without observing, that I never had my apparatus complete. The standard which I made for Sir George

Shuckburg

Shuckburgh Evelyn in 1796 was done by a mere make-shift contrivance, upon the principle of dividing by the eye; how I succeeded may be seen in Sir George's papers on Weights and Measures. (Phil. Trans. for 1798.) I made a second, some years after, for Professor Pictet of Geneva, which became the subject of comparison with the new measure of France, before the National Institute; and their report, drawn up by Mr. Pictet, has been ably re-stated and corrected by Dr. Young, as published in the Journals of the Royal Institution. I made a third for the Magistrates of Aberdeen. I notice the two latter, principally to give myself an opportunity of saying that, if those three scales were to be compared together, notwithstanding they were divided at distant periods of time, and at different seasons of the year, they would be found to agree with each other, as nearly as the different parts of the same scale agree.

I hope I may here be allowed to allude to an inadvertency which has been committed in the paper mentioned above; and which Sir George intended to have corrected, had he lived to conclude his useful endeavours to harmonize the discordant weights and measures of this country. The instruments which he has brought into comparison are, his own five feet standard measure and equatorial; General Roy's forty-two inch scale; the standard of Mr. Aubert; and that of the Royal Society. The inadvertency is this: in his equatorial, and the standard of the Royal Society, he has charged the error of the most erroneous extent, when compared with the mean extent, alike to both divisions; *i. e.* he has supposed one of the divisions, which bound the erroneous extent, to be too much to the right, and the other too much

much to the left, and that by equal quantities: this is certainly a good-natured way of stating the errors of work; and perhaps not unjustly so, where the worst part has been selected; but in the other three instances, namely, in General Roy's, Mr. Aubert's, and his own standard, he has charged the whole error of the most erroneous extent to one of the bounding lines.

I was well confirmed in my high opinion of the general accuracy of Bird's dividing, when, last winter *, I measured the chords of many arcs of the Greenwich quadrant: that instrument has indeed suffered both from a change in its figure, and from the wearing of its centre; but the graduation, considering the time when it was done, I found to be very good. Sir George in his Paper upon the Equatorial, (Phil. Trans. for 1795,) after some compliments paid to the divider of his instrument, says, "the late Mr. John Bird seems to have admitted a probable discrepancy in the divisions of his "eight feet quadrant amounting to 3";" and he refers to Bird on the construction of the Greenwich quadrant. This quantity being three times as great as any errors that I met with, I was lately induced to inquire how the matter stood. Bird, in the paper referred to, says, "in "dividing this instrument I never met with an inequality "that exceeded one second. I will suppose that in the "90 arc this error lay towards the left hand, and in the "95 arc that it lay towards the right, it will cause a "difference between the two arches of two seconds; "and, if an error of one second be allowed to the ob-"server in reading off his observation, the whole amount "is no more than three seconds, which is agreeable to "what I have heard, &c." Sir George's examination

* This paper was written in June 1802.

of

of his own equatorial furnishes me with the means of a direct comparison: in his account of the declination circle we find an error + 2″,35, and another — 1″,5; to these add an error of half a second in each, for reading off, which Sir George also admits, we shall then have a discrepancy of 4″,85; but, as the errors of reading off are not errors of division, let them be discharged from both, and the errors will then stand, for the quadrant 2″, and for the circle 3″,85. As the radius of the former, however, is four times greater than that of the latter, it will appear, by this mode of trial, that the Equatorial is rather more than twice as accurately divided as the quadrant. In doing justice to Bird in this instance, I have only done as I would be done by; for, should any future writer set me back a century on the chronological scale of progressive improvement, I hope some one will be found to restore me to my proper niche. I now subjoin a restatement of the greatest errors of each of the instruments that are brought into comparison by Sir George, after having reduced them all by one rule; viz. allowing each of the two points which bound the most erroneous extent to divide the apparent error equally between them. They are expressed in parts of an inch, and follow each other in the order of their accuracy.

Sir George Shuckburg's 5 feet standard .....,000165
General Roy's scale of 42 inches .....,000240
Sir George's Equatorial, 2 feet radius .....,000273
The Greenwich quadrant, 8 feet radius .....,000465
Mr. Aubert's standard, 5 feet long .....,000700
The Royal Society's standard 92 inches long ,000795

* This is the same which Mr. Bird used in dividing his eight feet mural quadrants, and was presented to the Royal Society by Bird's executors.

For the justness of the above statement I consider my name as pledged; requesting the permission to say, that if on the result of each respective examination, as here presented, there could have been more than one opinion, it would not have appeared here. I am further prompted to add, that the above comparative view presents one circumstance to our notice, which cannot do less than gratify every individual who is at all conversant in these matters; I mean, the high rank which General Roy's scale takes in the list; that scale having been made the agent in measuring the base line of our national trigonometrical survey.

To return, finally, to the dividing of circles; I must state, as matter of precaution, that great care should be taken during the turning of the outer edge, to have the circle of the same temperature; for one part may be expanded by heat, or contracted by cold, so much more than another, as to cause the numbers in the tables of errors to be inconveniently large. A night is not more than sufficient for allowing the whole to take the same temperature, after having been handled by the workmen; and the finishing touch should be given within a short space of time. But if the effects of temperature are to be regarded in turning a circle, it is of tenfold more importance to attend to this circumstance, while the examination of the larger arcs of the instrument is carried on; for it is absolutely necessary that, during this time, the whole circle should be of the same heat exactly. Few workmen are sufficiently aware of this: they generally suppose the expansion of metals to be a trifle which need not be regarded in practice; and wonder how the parts of a circle can be differently heated without taking pains to make it so. One degree of Fahren-

Fahrenheit's thermometer indicates so small a portion of heat that, in such places as workmen are usually obliged to do their business in, it is not very easy to have three thermometers attached to different parts of a large instrument, shewing an equality of temperature within that quantity; yet so necessary is correctness in this respect, that if a circle has the vertex one degree warmer than its opposite, and if this difference of temperature be regularly distributed from top to bottom, the upper semi-circle will actually exceed the lower by 2″: and if such should happen to be the case while the examination of the first dot of the third quadrant is made, the regularity of the whole operation would thereby be destroyed.

It may not be improper to remark, that dividing by the eye does not require a more expensive apparatus than the operation of dividing by hand; and, indeed, less so when the scale of inches is deemed necessary. The method by adjustment is still more expensive, requiring whatever tools Bird's method requires, and, in addition to these, a frame and microscopes, somewhat similar to those for dividing by the eye.

It is somewhat more difficult to give a comparative estimate of the time which the different methods of dividing require. I know that thirteen days, of eight hours each, are well employed in dividing such a circle by my method; about fifty-two days would be consumed in doing the same thing by Bird's method; and I think I cannot err much when I state the method by adjustment, supposing every dot to be tried, and that two-thirds of them want adjusting, to require about one hundred and fifty of such days.

The economy of time (setting aside the decided means of

of accuracy) which the above estimate of its application offers to view, will, I think, be considered of no little moment. By the rising artist who may aspire at excellence, it will at least, and I should hope, with gratitude, be felt in the abbreviation of his labours. To me, indeed, the means of effecting this became indispensible; and it has not been without a sufficient sense of its necessity, that I have been urged to the progressive improvement and completion of these means, as now described. It is but little that a man can perform with his own hands alone; nor is it on all occasions, even in frames of firmer texture than my own, that he can decisively command their adequate, unerring use. And I must confess that I never could reconcile it to what I hold as due to myself, as well as to a solicitous regard for the most accurate cultivation of the science of astronomy, to commit to others an operation requiring such various and delicate attentions as the division of my instruments.

That my attentions on this head have not failed to procure for me the notice and patronage of men whose approbation makes, with me, no inconsiderable part of my reward, I have to reflect on with gratitude and pleasure: and as I look with confidence to the continuance of that patronage so long as the powers of execution shall give me the inclination to solicit it, I cannot entertain a motive which might go to extinguish the more liberal wish of pointing out to future ingenuity a shorter road to eminence; sufficiently gratified by the idea of having in the present communication, contributed to facilitate the operations, and to aid the progress of art (as far as the limited powers of vision will admit) towards the point of perfection.

*Description*

## *Description of a reflective Goniometer.*

*By* WILLIAM HYDE WOLLASTON, *M. D. Sec. R. S.*

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY of LONDON.

With an Engraving.

FROM the advances that have been made of late years in crystallography, a very large proportion of mineral substances may now be recognised, if we can ascertain the angular dimensions of their external forms, or the relative position of those surfaces that are exposed by fracture. But though the modifications of tetrahedrons, of cubes, and of those other regular solids, to which the adventitious aid of geometry could be correctly applied, have been determined with the utmost precision, yet it has been often a subject of regret, that our instruments for measuring the angles of crystals are not possessed of equal accuracy, and that in applying the goniometer to small crystals, where the radius in contact with the surface is necessarily very short, the measures, even when taken with a steady hand, will often deviate too much from the truth to aid us in determining the species to which a substance belongs.

A means of remedying this defect has lately occurred to me, by which in most cases the inclination of surfaces may be measured as exactly as is wanted for common purposes, and when the surfaces are sufficiently smooth to reflect a distinct image of distant objects, the position of faces only $\frac{1}{10}$ of an inch in breadth may be determined with as much precision as those of any larger crystals.

For this purpose, the ray of light reflected from the surface is employed as radius, instead of the surface itself,

self, and accordingly for a radius of $\frac{1}{10}$ of an inch, we may substitute either the distance of the eye from the crystal, which would naturally be about twelve or fifteen inches; or for greater accuracy we may, by a second mode, substitute the distance of objects seen at a hundred or more yards from us.

The instrument which I use, consists of a circle graduated on its edge, and mounted on a horizontal axle, supported by an upright pillar (Fig. 2, Plate V). This axle being perforated, admits the passage of a smaller axle through it, to which any crystal of moderate size may be attached by a piece of wax, with its edge, or intersection of the surfaces, horizontal and parallel to the axis of motion.

This position of the crystal is first adjusted, so that by turning the smaller axle, each of the two surfaces, whose inclination is to be measured, will reflect the same light to the eye.

The circle is then set to *zero*, or 180°, by an index attached to the pillar that supports it.

The small axle is then turned till the further surface reflects the light of a candle, or other definite object to the eye; and, lastly, (the eye being kept steadily in the same place) the circle is turned by its larger axle, till the second surface reflects the same light. This second surface is thus ascertained to be in the same position as the former surface had been. The angle through which the circle has moved, is in fact the supplement to the inclination of the surfaces; but as the graduations on its margin are numbered accordingly in an inverted order, the angle is correctly shewn by the index, without need of any computation.

It may here be observed, that it is by no means necessary

sary to have a clean uniform fracture for this application of the instrument to the structure of laminated substances; for since all those small portions of a shattered surface that are parallel to one another (though not in the same plane), glisten at once with the same light, the angle of an irregular fracture may be determined nearly as well, as when the reflecting fragments are actually in the same plane.

In this method of taking the measure of an angle, when the eye and candle are only ten or twelve inches distant, a small error may arise from parallax, if the intersection of the planes or edge of the crystal be not accurately in a line with the axis of motion *; but such an error may be rendered insensible, even in that mode of using the instrument, by due care in placing the crystal; and when the surfaces are sufficiently smooth to reflect a distinct image of objects, all error from the same source may be entirely obviated by another method of using it.

For this purpooe, if the eye be brought within about an inch of the reflecting surface, the reflected image of some distant chimney may be seen inverted beneath its true place, and by turning the small axle may be brought to correspond apparently with the bottom of the house (or with some other distant horizontal line). In this position the surface accurately bisects the angle, which the height of that house subtends at the eye (or rather at the reflecting surface); then, by turning the whole

* I cannot omit mentioning, that Mr. Sowerby had thought of employing reflection for this purpose, nearly at the same time as myself; but did not succeed to his satisfaction, in consequence of an attempt to fix the position of the eye. For when the line of sight is determined by a point connected with the apparatus, the radius employed is thereby limited to the extent of the instrument, and the error from parallax is manifestly increased.

circle and crystal together, the other surface, however small, may be brought exactly into the same position; and the angle of the surfaces may thus be measured, with a degree of precision which has not hitherto been expected in goniometry.

The accuracy, indeed, of this instrument is such, that a circle of moderate dimensions, with a vernier adapted to it, will probably afford corrections to many former observations. I have already remarked one instance of a mistake that prevails respecting the common carbonate of lime, and I am induced to mention it, because this substance is very likely to be employed as a test of the correctness of such a goniometer, by any one who is not convinced of its accuracy from a distinct conception of the principles of its construction.

The inclination of the surfaces of a primitive crystal of carbonate of lime is stated, with great appearance of precision, to be 104° 28′ 40″: a result deduced from the supposed position of its axis at an angle of 45° with each of the surfaces, and from other seducing circumstances of apparent harmony by simple ratios. But however strong the presumption might be that this angle, which by measurement approaches to 45°, is actually so, it must nevertheless be in fact about 45° 20′; for I find the inclination of the surfaces to each other is very nearly, if not accurately 105°, as it was formerly determined to be by Huygens *; and since the measure of the superficial angle given by Sir Isaac Newton † corresponds with the determination of Huygens, his evidence may be considered as a further confirmation of the same re-

* Huygenii Opera Reliqua, tom. I. p. 73—Tract. de Lumine.

† Newton's Optics, 8vo. p. 329. Qu. 25. concerning Iceland Crystal.

sult;

sult; for it may be presumed, that he would not adopt the measures of others without a careful examination.

REFERENCE TO THE ENGRAVING.

*a b* (Fig. 2, Plate V), is the principal circle of the goniometer graduated on its edge.

*c c*, the axle of the circle.

*d*, a milled head by which the circle is turned.

*e e*, the small axle for turning the crystal, without moving the circle.

*f*, a milled head on the small axle.

*g*, a brass plate supported by the pillar, and graduated as a vernier to every five minutes.

*h*, the extremity of a small spring, by which the circle is stopped at 180°, without the trouble of reading off.

*i i* and *k k*, are two centres of motion, the one horizontal, the other vertical for adjusting the position of a crystal: one turned by the handle *l*, the other by the milled head *m*.

The crystal being attached to a screw-head at the point *n* (in the centre of all the motions), with one of its surfaces as nearly parallel as may be to the milled head *m*, is next rendered truly parallel to the axis by turning the handle *l* till the reflected image of a horizontal line is seen to be horizontal.

By means of the milled head *f*, the second surface is then brought into the position of the first, and if the reflected image from this surface is found not to be horizontal, it is rendered so by turning the milled head *m*; and since this motion is parallel to the first surface, it does not derange the preceding adjustment.

*Chemical Analysis of a Black Sand, from the River Dee in Aberdeenshire; and of a Copper Ore, from Arthrey in Stirlingshire. By* THOMAS THOMPSON, *M. D. Lecturer on Chemistry, Edinburgh.*

From the TRANSACTIONS of the ROYAL SOCIETY of EDINBURGH.

THE specimen which formed the subject of the first of the following *analyses*, was brought from the banks of the river Dee, about seven years ago, by my friend Mr. James Mill, who at that time resided in Aberdeenshire. By him I was informed, that considerable quantities of it are found in different parts of the bed of that river,—that it is called by the inhabitants *iron-sand*,—and that they use it for sanding newly written paper. I tried some experiments in the year 1800, in order to ascertain its nature; but was too little skilled at that time, both in mineralogy and practical chemistry, to manage an analysis of any considerable difficulty.

The black powder is mixed with a good many small whitish, reddish, and brownish grains, which, when examined by means of a glass, prove to be pieces of quartz, felspar, and mica. From this it would appear, that the sand of the river Dee consists chiefly of the detritus of granite or gneiss.

When a magnet is passed over the sand, some of the black grains adhere to it, and are by this means easily obtained separate. But after all that can be attracted by the magnet is removed, the greater part of the black powder still remains. This residue is indeed attracted by a powerful magnet, but so very feebly, that it is not possible by means of it to separate it from the grains of sand

sand with which it is mixed. Thus we learn, that the black matter consists of two distinct substances; one of which is powerfully attracted by the magnet, the other not. As this second substance was obviously specifically heavier than the grains of sand with which it was mixed, I placed a quantity of the powder on an inclined plane, and by exposing it cautiously, and repeatedly, to a jet of water, I succeeded in washing away most of the grains of sand, and thus obtained it in a state of tolerable purity.

The first of these minerals we may call *iron-sand*, and the second *iserine*, as they belong to mineral species which oryctognosts have distinguished by these names.

## I. *Iron-Sand.*

The iron-sand is much smaller in quantity than the iserine, and does not exceed one-fourth of the mixture at most. Its colour is iron-black. It is in very small angular grains, commonly pretty sharp-edged, and sometimes having the shape of imperfect octahedrons. The surface is rough; the lustre is feebly glimmering and metallic; the fracture, from the smallness of the grains, could not be accurately ascertained, but it seemed to be conchoidal. Opake, semihard, brittle, easily reduced to powder. Powder has a greyish-black colour; powerfully attracted by the magnet; specific gravity 4.765.

1. As acids were not found to act upon this mineral, 100 grains of it were reduced to a fine powder, mixed with twice its weight of carbonate of potash, and exposed for two hours to a red heat, in a porcelain crucible. The mass, being softened in water, was digested in muriatic acid. By repeating this process twice, the whole

whole was dissolved in muriatic acid, except a brownish-white matter, which being dried in the open air, weighed 19½ grains.

2. The muriatic acid solution, which had a deep yellowish-brown colour, was concentrated almost to dryness, and then diluted with water. It assumed a milky appearance; but nothing was precipitated. Being boiled for some time, and then set aside, a curdy-like matter fell. It was of a milk-white colour, weighed, when dry, seven grains, and possessed the properties of oxyd of titanium.

3. The residual liquid being supersaturated with ammonia, a dark reddish-brown matter precipitated, which being separated by the filter, dried, drenched in oil, and heated to redness, assumed the appearance of a black matter, strongly attracted by the magnet. It weighed 93.7 grains, and was oxyd of iron.

4. The 19.5 grains of residual powder, being mixed with four times its weight of carbonate of soda, and exposed for two hours to a red heat, in a platinum crucible, and afterwards heated with muriatic acid, was all dissolved, except about a grain of blackish matter, which was set aside.

5. The muriatic solution being concentrated by evaporation, a little white matter was separated. It weighed one-fourth of a grain, and possessed the characters of oxyd of titanium.

6. When evaporated to dryness, and redissolved in water, a white powder remained, which proved to be silica, and which, after being heated to redness, weighed one grain.

7. The watery solution being supersaturated with potash, and boiled for a few minutes, was thrown upon a filter,

a filter, to separate a reddish-brown matter, which had been precipitated. The clear liquid which passed through the filter, was mixed with a solution of sal ammoniac. A soft white matter slowly subsided. It was alumina, and, after being heated to redness, weighed half a grain.

8. The brown-coloured matter which had been precipitated by the potash, when dried upon the steam-bath, weighed 20.2 grains. It dissolved with effervescence in muriatic acid. The solution had the appearance of the yolk of an egg. When boiled for some time, and then diluted with water, it became white, and let fall a curdy precipitate, which weighed, when dry, 4.6 grains, and possessed the properties of oxyd of titanium.

9. The residual liquor being mixed with an excess of ammonia, let fall a brown matter, which, after being dried, drenched in oil, and heated to redness, weighed 6 grains. It was strongly attracted by the magnet, but was of too light a colour to be pure oxyd of iron. I therefore dissolved it in muriatic acid, and placed it on the sand-bath, in a porcelain capsule. When very much concentrated by evaporation, small white needles began to make their appearance in it. The addition of hot water made them disappear: but they were again formed when the liquor became sufficiently concentrated. These crystals, when separated, weighed 1.5 grains, and proved, on examination, to be white oxyd of arsenic. During the solution of the 6 grains in muriatic acid, a portion of black matter separated. It weighed 0.2 grains, and was totally dissipated before the blow-pipe in a white smoke. Hence, it must have been arsenic. These 1.5 grains are equivalent to rather more

more than 1 grain of metallic arsenic. Thus, it appears, that the 6 grains contained 1 grain of arsenic, which explains the whiteness of their colour. The rest was iron. It can scarcely be doubted, that the proportion of arsenic present was originally greater. Some of it must have been driven off when the iron oxyd was heated with oil.

10. The insoluble residue, (No. 4.), was with great difficulty dissolved in sulphuric acid. When the solution was mixed with ammonia, a white powder fell, which weighed 0.8 grains. It was accidentally lost, before I examined its properties. But I have no doubt, from its appearance, that it was oxyd of titanium.

11. Thus, from the 100 grains of iron-sand, the following constituents have been extracted by analysis:

| | |
|---|---|
| Black oxyd of iron | 98.70 |
| White oxyd of titanium | 12.65 |
| Arsenic | 1.00 |
| Silica and alumina | 1.50 |
| Total, | 113.85 |

Here there is an excess of nearly 14 grains, owing, without doubt, to the combination of oxygen with the iron and the titanium during the analysis.

Had the iron in the ore been in the metallic state, the excess of weight, instead of 14, could not have been less than 30. For the black oxyd is known to be a compound of 100 metal and 37 oxygen. Hence, I think, it follows, that the iron in our ore must have been in the state of an oxyd, and that it must have contained less oxygen than black oxyd of iron. A good many trials, both on iron-sand, and on some of the other magnetic ores of iron, induce me to conclude, that the iron in most

most of them is combined with between 17 and 18 *per cent.* of oxygen. This compound, hitherto almost overlooked by chemists, I consider as the real protoxyd of iron. Thenard has lately demonstrated the existence of an oxyd intermediate between the black and the red; so that we are now acquainted with four oxyds of this metal. But the protoxyd, I presume, does not combine with acids like the others. Analogy leads us to presume the existence of a fifth oxyd, between the green and the red.

As to the titanium, it is impossible to know what increase of weight it has sustained, because we are neither acquainted with it in the metallic state, nor know how much oxygen its different oxyds contain. It is highly improbable, that in iron-sand the titanium is in the metallic state, if it be made out that the iron is in that of an oxyd. The experiments of Vauquelin and Hecht, compared with those of Klaproth, have taught us that there are three oxyds of titanium, namely, the blue, the red, and the white. From an experiment of Vauquelin and Hecht, and from some of my own, I am disposed to consider these oxyds as composed of the following proportions of metal and oxygen:

| | Metal. | Oxygen. |
|---|---|---|
| 1. Blue, | 100 | 16 |
| 2. Red, | 100 | 33 |
| 3. White, | 100 | 49 |

I find, that when the white oxyd of titanium is reduced to the state of red oxyd, it loses one-fourth of its weight; and that red oxyd, when raised to the state of white oxyd, increases exactly one-third of its weight. It was the knowledge of these facts, that led me to the

preceding numbers. And I think they may be used till some more direct experiment lead us to precise conclusions.

Red oxyd being the only state in which this metal has yet occurred separate, we may conclude that it combines, in this state, with metallic oxyds, and that the titanium in iron-sand, is most probably in this state. But white oxyd, diminished by one-fourth, gives us the equivalent quantity of red oxyd. On that supposition, the titanium present, before the analysis, in the 100 grains of ore, weighed 9.5 grains.

The appearance of the arsenic surprised me a good deal, as it was altogether unexpected. I am disposed to ascribe it to some particles of arsenic pyrites which might have been accidentally present. This conjecture will appear the more probable, when we reflect, that arsenic pyrites very frequently accompanies iron-sand. Before the microscope, the iron-sand appears to contain some white shining particles, which, probably, are arsenic pyrites.

The small quantity of silica and alumina, I ascribe, without hesitation, to grains of quartz and felspar, which had adhered to the iron-sand, and been analysed along with it. Some such grains were actually observed and separated. But others probably escaped detection.

12. If these suppositions be admitted as well founded, the iron-sand was composed of

| | |
|---|---|
| Protoxyd of iron, | 85.3 |
| Red oxyd of titanium, | 9.5 |
| Arsenic, | 1.0 |
| Silica and alumina, | 1.5 |
| Loss, | 2.7 |
| | 100.0 |

The

The loss will not appear excessive, if we consider, that a portion of the arsenic must have been sublimed, before the presence of that metal was suspected.

Upon the whole, I think we may consider the specimen of iron-sand examined, as composed of 9 parts protoxyd of iron, and 1 of red oxyd of titanium. The presence of titanium in this ore had been already detected by Lampadius, though, as I have not seen his analysis, I cannot say in what proportion.

### II. *Iserine.*

The colour of this ore is iron-black, with a shade of brown. It consists of small angular grains, rather larger than those of the iron-sand, but very similar to them in their appearance. Their edges are blunt; they are smoother, and have a stronger glimmering lustre than those of the iron-sand. Lustre semi-metallic, inclining to metallic. The fracture could not be distinctly observed, but it seemed to be conchoidal; at least nothing resembling a foliated fracture could be perceived. Opake, semihard, brittle, easily reduced to powder; colour of the powder unaltered; specific gravity 4.491*; scarcely attracted by the magnet.

1. A hundred grains of the powdered ore were mixed with six times their weight of carbonate of soda, and exposed for two hours to a red heat, in a platinum crucible. The mass obtained, being softened with water, dissolved completely in muriatic acid. When the solution was concentrated, it assumed the appearance of the yolk of an egg. It was boiled, diluted with water, and set aside

* If, as the following analysis would lead us to expect, the specimen examined was a mixture of four parts iserine, and one part quartz and felspar, the specific gravity of pure iserine should be 4.964.

for some time. A white matter gradually deposited, which, when dried on the steam-bath, weighed 53 grains, and possessed the properties of oxyd of titanium.

2. The liquid thus freed from titanium, was evaporated to dryness, and the residue redissolved in water, acidulated with muriatic acid. A white powder remained, which, after being heated to redness, weighed 16.8 grains, and possessed the properties of silica.

3. The solution was precipitated by ammonia, and the brown matter which had separated, boiled for some time in liquid potash. The whole was then thrown on a filter, to separate the undissolved part, and the liquid which came through, was mixed with a solution of sal ammoniac. A white powder fell, which, after being heated to redness, weighed 3.2 grains. It was alumina.

4. The brown substance collected on the filter, was dried, drenched in oil, and heated to redness. It was strongly attracted by the magnet, and weighed 52 grains.

5. It was digested in diluted sulphuric acid; but not being rapidly acted upon, a quantity of muriatic acid was added, and the digestion continued. The whole slowly dissolved, except a blackish matter, which became white when exposed to a red heat, and, as far as I could judge from its properties, was oxyd of titanium, slightly contaminated with iron. It weighed 1.8 grains.

6. The acid solution being concentrated by gentle evaporation, a number of small yellowish-coloured needles made their appearance in it. By repeated evaporations, all the crystals that would form were separated. They weighed 6 grains. I redissolved them in water, and added some ammonia to the solution. A fine yellow powder fell, which I soon recognised to be oxyd of uranium. It weighed 4.2 grains.

7. Thus

7. Thus it appears, that the 52 grains (No. 4.), attracted by the magnet, contained 46 grains of iron, and 6 grains of uranium and titanium.

8. The following are the substances separated from 100 grains of iserine, by the preceding analysis:

| | |
|---|---|
| Oxyd of titanium, | 54.8 |
| Oxyd of iron | 46.0 |
| Oxyd of uranium, | 4.2 |
| Silica, | 16.8 |
| Alumina | 3.2 |
| Total | 125.0 |

Here is an excess of no less than 25 grains, to be accounted for by oxygen, which must have united to the three metals during the process. As to the silica and alumina, there can be little hesitation in ascribing them to grains of sand, which had been mixed with the ore. The pure iserine, in all probability, was composed of iron, titanium, and uranium. If we suppose that each of these metals existed in the state of protoxyd, we must diminish the titanium by one-fourth, the iron by one-seventh nearly, and the uranium, according to Bucholz's experiments, by one-fifth. This would give us,

| | |
|---|---|
| Titanium, | 41.1 |
| Iron, | 39.4 |
| Uranium, | 3.4 |
| Silica and alumina, | 20.0 |
| | 103.9 |

Here, then, is still an excess of nearly 4 *per cent.* But this I am disposed to ascribe to the oxyds of titanium and uranium, having been only dried upon the steam-bath.

bath. Upon the whole, it appears, that, in the specimens of iserine analysed, the proportions of titanium and iron were nearly equal, and that the uranium did not exceed 4 *per cent.* The appearance of uranium surprised me a good deal. I perceive, however, that it has already been detected in this ore, from an analysis published by Professor Jameson, in the second volume of his Mineralogy, which, I understand, was made by Lampadius. The specimen examined by Lampadius yielded very nearly 60 parts of titanium, 30 of iron, and 10 of uranium. Whereas, in mine, if the foreign matter be removed, there was obtained very nearly,

48 titanium,
48 iron,
4 uranium,

100

But, there can be no doubt, that the iserine which I analysed was still contaminated with a good deal of iron-sand; for it was impossible to remove the whole.

*Analysis of the Grey Copper Ore, from Airthrey.*

The copper mine of Airthrey, near Stirling, consists of a thin vein, which runs through the west corner of the Ochils. It has been twice wrought, by two different companies; but, in both cases, was abandoned, after a few years trial. I went to it some years ago, and examined the ore, at the request of one of the proprietors. The specimens which were employed for the subsequent analysis, were the purest that I could select, out of a considerable

considerable quantity. I was told, however, that from the lower level, which was at that time full of water, much richer ore had been extracted. But, afterwards, when the lower level was freed from its water, I went down to it myself, and found the ore precisely of the same kind as in the upper, with this difference, that it was more mixed with calcareous spar, and perhaps, on that account, more easily smelted.

The veinstones in the Airthrey mine are sulphate of barytes, and carbonate of lime, and with these the ore is almost always more or less mixed.

The colour is at first light steel-grey; but the surface soon tarnishes, and becomes of a dark dull leaden-grey, and in some places assumes a beautiful tempered steel tarnish. Massive and disseminated. In some specimens, it exhibits the appearance of imperfect crystals. Internal surface shining and metallic; but, by exposure, it soon becomes dull. Fracture small-grained, inclining to even. Fragments indeterminate, and rather blunt-edged. Semihard, the degree being almost the same as that of calcareous spar; for these two minerals reciprocally scratch each other. Streak similar, opake, brittle, easily frangible; specific gravity 4.878.

1. To free the ore as completely as possible from foreign matter, it was reduced to a coarse powder, and carefully picked. It was then digested in diluted muriatic acid, which dissolved a quantity of carbonate of lime, amounting to 13 *per cent.* of the original weight of the ore.

2. Thus purified, it was dried on the steam-bath, and 100 grains of it were reduced to a fine powder, and digested in diluted nitric acid, till every thing soluble in that

that menstruum was taken up. The residue was digested in the same manner, in muriatic acid; and when that acid ceased to act, the residue was treated with nitro-muriatic acid till no further solution could be produced. The insoluble matter was of a white colour; it weighed 6.9 grains, and was almost entirely sulphate of barytes. No traces of sulphate of lead, nor of oxyd of antimony, could be detected in it by the blow-pipe.

3. The three acid solutions being mixed together, no cloudiness appeared, nor was any change produced; a proof that the ore contained no silver.

4. The solution being evaporated nearly to dryness, was diluted with water, and precipitated by muriate of barytes. By this means, the sulphuric and arsenic acids, which had been formed during the long-continued action of the nitric acid on the ore, and the presence of which had been indicated by re-agents, were thrown down; for nitrate of lead, added to the residual liquid, occasioned no precipitate; a proof that no arsenic acid was present.

5. The liquid, thus freed from arsenic acid, was mixed with an excess of ammonia. It assumed a deep blue colour, while a brown matter precipitated. It was separated by the filter, and being dried, drenched in oil, and heated to redness, it was totally attracted by the magnet. It weighed 45.5 grains, and was iron.

6. The ammoniacal liquid was neutralised by sulphuric acid, and the copper thrown down by means of an iron plate. It weighed 17.2 grains.

7. To ascertain the quantity of sulphur and arsenic, 100 grains of the purified ore, in the state of a fine powder, were put into the bottom of a coated glass tube, and

and exposed for two hours to a red heat. When the whole was cold, and the bottom of the tube cut off, the ore was found in a round solid mass, having the metallic lustre, a conchoidal fracture, and the colour and appearance of *variegated copper ore.* It had lost 16 grains of its weight.

8. The upper part of the tube was coated with a yellowish-brown substance, like melted sulphur. It weighed 12.6 grains. Thus, there was a loss of 3.4 grains. As the tube was long, this loss can scarcely be ascribed to sulphur driven off. I rather consider it as water. For towards the beginning of the process, drops of water were very perceptible in the tube. Whether this water was a constituent of the ore, or derived from the previous digestion in muriatic acid, cannot be determined.

9. When the 12.6 grains of yellowish-brown matter, detached from the tube, were digested in hot potash-ley, the whose was dissolved, except a fine blackish powder, which weighed one grain, and was arsenic. The dissolved portion I considered as sulphur.

10. The potash solution, being mixed with nitric acid, four grains of sulphur fell. The remaining 7.6 grains must have been converted into sulphuric acid by the action of the nitric acid. Accordingly, muriate of barytes occasioned a copious precipitate.

11. The 84 grains of roasted ore being reduced to a fine powder, mixed with half their weight of pounded charcoal, and roasted a second time in a glass tube, one grain of sulphur sublimed. But the tube breaking before the roasting had been continued long enough, the process was completed in a crucible. The roasted ore weighed 70 grains.

12. From the preceding analysis we learn that the constituents of the Airthrey ore are as follows:

| | |
|---|---|
| Iron, | 45.5 |
| Copper, | 17.2 |
| Arsenic, | 14.0 |
| Sulphur, | 12.6 |
| Water, | 3.4 |
| Foreign bodies, | 6.9 |
| | 99.6 |
| Loss, | .4 |
| | 100.0 |

If we suppose the water and the earthy residue to be only accidentally present, then the only essential constituents are the first four, and the ore would be a compound of

| | |
|---|---|
| Iron, | 51.0 |
| Copper, | 19.2 |
| Arsenic, | 15.7 |
| Sulphur, | 14.1 |
| | 100.0 |

If we compare this analysis with several analyses of grey copper ore, lately published by Klaproth, we shall find that the constituents are the same in both; but the proportions of the two first ingredients are very nearly reversed. Klaproth obtained from 0.4 to 0.5 of copper, and from 0.22 to 0.27 of iron. This renders it obvious, that the two ores were not in the same state. I have little doubt that the difference, however, is merely apparent, and that it arose altogether from a quantity of iron pyrites, and perhaps also of arsenic pyrites, which I could not separate from the grey

grey copper ore which I examined. Both of these minerals could be distinctly seen in many of the specimens, intimately mixed with the grey copper; and I have no doubt that the same mixture existed, even in those specimens which were selected as purest. The difference in the proportions of copper and arsenic, obtained by Klaproth * in his various analyses, is so considerable, as to lead to a suspicion, that even his specimens, in all probability, contained a mixture of foreign matter.

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## *On the Action of Phosphorus, and oxymuriatic acid Gas upon alkaline Substances.*

*By Messrs.* BOUILLON, LAGRANGE, *and* VOGEL.

From the ANNALES DE CHIMIE.

SOME years ago it was observed, that, after a large quantity of phosphuretted hydrogen had been obtained from pure caustic potash dissolved in water, and heated with phosphorus, there remained a blackish mass, from whence there was afterwards emitted another gas, which did not take fire by contact of air.

This object not having appeared sufficiently interesting to be followed up, the memorandum that had been made of it was, as it were, forgot, and probably would have been neglected to this moment, if, on delivering a lecture very lately on phosphorus, the same phenomena had not presented themselves afresh.

Being struck at the same time with the discovery of Mr. Davy respecting the constitution of the alkalies, the

* Gehlen's Journal, vol. V. pp. 9. 11. 13.

facts which had been formerly neglected could no longer be regarded with indifference.

It is not intended to take up any time in relating the decomposition of potash by the processes employed by Messrs. Thenard, Gay Lassac, and Curaudau. It is sufficient to observe that the experiment of the decomposition of soda by charcoal, in a gun-barrel, as it had been exhibited by Mr. Curaudau, was repeated in the presence of the pupils who attended the course of chemistry, and it succeeded in the most complete manner.

The experiments now to be related were made with phosphorus upon potash and soda. At present, nothing but the mere matter of fact will be given, and the greatest caution will be used to abstain from all hypothetical reasoning, being persuaded that to offer at a hazard explanations which are not founded upon facts that cannot be disputed, or which require further explanations, there can only result errors which, instead of advancing the science, would only produce a confusion of ideas.

In order to obtain a mixture of phosphorus with potash, a mixture which it seemed impossible to produce without employing the means here proposed, phosphorus was melted in a flask in which hot water had been poured. It was shook until the water had become quite cold; the cooling was promoted by plunging the flask, towards the end, in cold water, still continuing the agitation of it. By this means the phosphorus was reduced to a pulverulent form. The supernatant water was decanted, and its place supplied by diluted oxymuriatic acid. It is known that, according to Mr. Juch of Wurzburg,

Wurzburg, this acid has the property of abstracting carbon from phosphorus, if it be true that phosphorus contains this substance. It lost its colour, became white, and, when in this state, the acid was separated. The moisture was afterwards abstracted by blotting-paper.

On the other hand, the purity of the potash was ascertained by treating it over again with alkohol, and by trying it, after it had been exactly melted, by means of lime-water and barytes-water. It may here be remarked, that lime-water is not a certain means of discovering whether the potash contains any carbonic acid; for, if the mixture has been diluted with water, a small quantity of carbonate of lime will be taken up. This redissolution does not take place when barytes is employed, so that the smallest quantity of carbonate of barytes is always visible, which renders this substance preferable to lime for examining the purity of caustic potash or soda *.

The caustic potash was reduced to powder in a glass mortar, and an equal quantity of phosphorus, prepared as mentioned above, was added to it; and, in order to prevent its taking fire, as happened before it was cooled, the mortar was placed in a mixture of ice and muriate of

* It has been known for a long time that the concentrated solution of caustic potash was precipitated by lime water, and that this precipitate was soluble in a large quantity of water, from which it was concluded that potash, taking the water from the lime, threw down the latter in a caustic state.

But it is certain that this precipitate is in reality carbonate of lime, which, being so much divided, is soluble in water. It has also been observed, that this solution does not take place by reason of an excess of alkali, because on passing carbonic acid gas through lime water, the precipitate which is thrown down is equally soluble in water, and yet the liquid was neutral.

soda.

soda. A slight trituration was sufficient, and the matter was immediately introduced into a luted stone-ware retort, which was placed upon the grate of a reverberatory furnace. A safety tube was adapted to the mouth of the retort, which was made to communicate with a bell-glass in a mercurial apparatus. The whole being thus disposed, it was slightly heated. This first degree of heat sometimes occasioned the inflammation of a small quantity of phosphorus. This inflammation might be avoided by covering the mixture with a little pulverized potash. It is easy to discover that this inflammation arises from the air contained in the retort; but when the phosphorus does not come into contact with it, at the time when the heat drives out the air from the apparatus, it cannot take fire. That this explanation is right was shewn by an experiment made on purpose. The heat was then gradually augmented until the retort became of a white heat.

A gas, whose properties are hereafter described, was disengaged during the whole course of the operation.

TO BE CONCLUDED IN OUR NEXT.

## *On the Volatilization of Substances. By M.* GAY-LUSSAC.

From the MEMOIRES DE LA SOCIETE D'ARCUEIL.

EVERY person who has made any chemical experiments, and carefully attended to all the circumstances, must have observed, that when a substance is exposed to heat in a vessel which has no immediate communication with the atmosphere, or at least a very slight communication, that no sensible volatilization of the substance takes place at a few degrees below the heat necessary for its ebullition, although it would yield vapours abundantly under the same circumstances in the free air. They must also have observed that on decomposing one substance by another, it frequently happens, at the usual temperature, the decomposition does not take place in close vessels, but is performed either totally or partially when the mixture is exposed to the open air. The facts of this kind which might be cited are extremely numerous, but as yet no person has endeavoured to explain a single instance of this kind, and still less to shew that they all depend upon the same cause. It is therefore proposed to supply in this paper the silence that has been kept on this subject. After having mentioned a few facts among those which are the most familiar to the generality of persons, an explanation of them, founded upon the knowledge already possessed respecting evaporation, will be given; and they will be afterwards applied to some phenomena which take place in the distillation of a mixture of two substances slightly differing in volatility.

When concentrated sulphuric acid is poured upon nitrate of potash, vapours of nitric acid are disengaged; with

with any heat being used, these vapours continue for a very long time in the open air; but if the air cannot be changed upon the surface of the mixture, they very soon cease.

Muriate of potash may be kept in fusion for many hours without any sensible loss of its weight, provided the air cannot be easily changed upon its surface; for otherwise the loss by evaporation will be considerable. Thirty grains of this salt well dried were taken, kept in fusion in a platina crucible, and the air kept from it only by the cover of the crucible, which did not exactly fit; the loss during 30 minutes was only 0.085 grains. On repeating the same experiment without covering the crucible, the loss was 0.62 grains, that is to say, seven times greater than in the former experiment, although the temperature of the salt was necessarily lower on account of the rapid change of air on its surface. As soon as the crucible was covered, no vapours could be perceived at the small openings between it and the cover; but, as soon as the crucible was uncovered, the vapour appeared in great abundance. It is therefore certain, from these experiments, and many others that were made by covering the crucible more or less, that the loss of weight might be reduced nearly or even quite to nothing by covering it so exactly as to exclude all communication with the circumambient atmosphere, notwithstanding no resistance was exposed to the effect of the interior vapour. So that when it is desired to separate the water from salts that are only slightly volatilizable, they may be kept ignited for 30 minutes or more without the fear of losing any part of their substance by volatilization, provided the crucible be exactly covered; for what has just been said of muriate of pot-

ash

ash may be extended to other salts, as the experiment has been tried upon several, and particularly upon the muriates of soda and of iron, both of which exhibited the same phenomena, a very slight volatilization or none in covered crucibles, but on the other hand very abundant vapour in open vessels. In the same manner potash, or soda, smoke very little in the first case, and greatly in the second.

It would be in vain to attempt to distil zinc in a vessel that had but a slight communication with the air, and equally heated in all respects, provided the temperature was not sufficient to cause it to boil. A mixture of charcoal and oxyd of zinc nevertheless yields in similar circumstances a very fine metallic sublimate. It is also known that, in order to make flowers of zinc, there is required not only the oxydizement of the metal, but also a current of air upon the surface of it.

Lead, antimony, and bismuth smoke a great deal at a red heat in open crucibles, and appear of course to be very volatile. In covered crucibles they do not yield any sublimate, and appear on the other hand to be very fixed.

It is also an analogous fact, that flowers of sulphur cannot be prepared in a very small distilling apparatus. In order to volatilize sulphur in such an apparatus, it requires a temperature sufficiently elevated to cause it to boil, or at least but little lower. In this case, therefore, the internal part of the small receiver where the condensation takes place, being itself very hot, the sulphur that condenses in it does not become solid immediately; it agglutinates upon the sides as it is condensed, and there is only obtained a solid mass of sulphur. If, on the contrary, the receiver is very large, like the cham-

bers usually employed for this purpose, the current of air upon the surface of the sulphur is much more rapid, the temperature of the internal part of the recipient is much lower, and the vapours that are condensed in it become solid immediately, forming a light powder, which does agglutinate as it condenses upon the sides of the chamber, and therefore forms the flowers of sulphur.

Lastly, in order not to multiply examples, and to finish with a fact well known to all the world, and which will serve to explain all the others, it is only necessary to mention the evaporation of water.

It is well known that when this liquid is exposed to the air, it evaporates at all temperatures. But Fontana has shewn, a long time ago, that if a distilling vessel in which it is enclosed communicates only by a small aperture with the receiver, although the receiver be very large, yet the distillation does not take place unless a current of air is established in the apparatus.

This example is perfectly analogous to the preceding examples; and it will be sufficient to call to mind, in a few words, the different circumstances that are already known respecting the conversion of water into vapour, in order to explain the whole of them.

When water bears immediately upon its surface, a column of quicksilver, equal for example to the pressure of the atmosphere, it is not reduced into steam until the vapour acquires an elastic force capable of overcoming this pressure. In vacuo, on the other hand, as also in the air, or in any gas, water is reduced to vapour at any temperature; and it has been recognized as a principle, that the density of its vapour in any space, whether void or occupied by an elastic fluid which has no sensible chemical action upon the vapour, depends entirely

tirely upon the temperature. Upon these principles, which are too well known to be further insisted upon, it may be easily conceived, that although water yields vapour in a space occupied by air, but circumscribed, and either not communicating with the external air, or with a recipient, unless it be by a small opening that hinders the renewal of the air, cannot be evaporated at a temperature below that of its ebullition. As soon as the vapour has acquired the density which it ought to have in that space, no new vapour can be formed unless some more air arrives to replace that which is already saturated with the vapour. The same thing happens with muriate of potash, which does not evaporate in a crucible nearly closed, notwithstanding it evaporates very fast when the air has a free access to it. It is also the same that happens in the distillation of a mixture of charcoal and oxyd of zinc, during which gaseous oxyd of carbon is disengaged, and carries along with it the vapour of the zinc as fast as it is formed. And lastly, it is the same that takes place in all the examples that have been cited, and which it would be easy to increase to a much greater number.

It must, however, be remarked, how important it is to pay attention to the evaporation of substances by means of air, in order that errors may not be committed. In order to estimate the volatility of a body it can only be estimated comparatively, and by assuming as a measure the products it yields by volatilization. But if attention is not paid to that property of bodies of their not being able to be evaporated at a temperature below that of ebullition, when they are inclosed in vessels which have little or no communication with the air, notwithstanding the contrary takes place in similar circumstances in the

open air, a substance which might appear fixed in the one case would necessarily be looked upon as very volatile in the other. For example, muriate of potash and antimony smoke a great deal when they are ignited and exposed to the air: it might therefore be concluded, and with good reason, that they were reduced at this temperature into vapour. But if the crucibles in which they are inclosed are slightly covered, they suffer no sensible loss of their weight; and if attention was not paid to the difference of the circumstances, it might be concluded, on the contrary, that they were fixed.

This principle, that the vapours of a substance may be formed indefinitely in the open air, and that their density depends only on the temperature, is applicable to the distillation of two bodies which are only mixed together, and do not differ much in volatility; and it serves to explain why the most volatile body does in this case carry off some of the other. Although attraction is not excluded from among the causes which may contribute to that effect, yet the effect may perhaps also take place without it; and it will be of course supposed that the vapours of the two bodies have no attraction among themselves, and act upon one another as oxygen upon azote.

When, therefore, a mixture of two bodies slightly differing in volatility are submitted to the action of heat, for example, alkohol and water, they soon begin to boil, at which time the alkohol has acquired the whole of its expansive force, while the water has only acquired one part of that which it is capable of acquiring under the same pressure by an elevation of the temperature. If, however, water only was in the distilling vessel, it is evident, from what has been said above,

above, that being as yet far removed from its own boiling point, it could not distil over without a current of air. But as the alkohol that is mixed with it is boiling, an elastic fluid is formed whose action upon the water supplies the place of air, and the two fluids pass over in proportions that depend upon those of the mixture. It is evident, therefore, that alkohol perfectly free from water is impossible to be obtained. Better success would be obtained by distilling the mixture under a less pressure than that of the atmosphere, because it would then boil much sooner, and of course the proportion between the vapour of the alkohol and that of the water would be much greater. But the two fluids cannot be perfectly separated by this means, and it is most advantageous to follow the usual practice of adding to the mixture a fixed body, such as muriate of lime, which, having a considerable attraction for water, diminishes its volatility much more than that of the alkohol. It is for the same reason that the muriates of tin and antimony cannot be separated by the action of heat, although they are not equally volatile.

It is useless to cite other facts, perfectly analogous, as they are capable of the same explanation. To finish this paper, it is sufficient to state that water is necessary in order to decompose limestone and many other carbonates by heat, in order to fix the attention of chemists upon a very singular fact, which in some respects is analogous to those that have been treated of in this paper, but in other respects appears, on the contrary, to differ from them.

*List*

*List of Patents for Inventions, &c.*

(Continued from Vol. XV. Page 376.)

JOSEPH BRAMAH, of Pimlico, in the county of Middlesex, Engineer; for certain new improvements in the constructing and making wheels for all kinds of carriages; and also a new method of locking or sleding the wheels of carriages when passing down steep declining hills. Dated November 2, 1809. Specification to be enrolled within two months.

JOHN ISAAC HAWKINS, of Great Titchfield-street, in the county of Middlesex, Machinist; for a certain instrument, machine, or manufacture, applicable in mechanics as a balance or equipoise. Dated November 2, 1809. Specification to be enrolled within two months.

JOHN BARTON, of Argyle-street, Westminster, in the county of Middlesex, Gentleman; for a lamp of a new construction, acting upon the natural unerring principle of the difference of gravity between two fluids, which produces a constant supply of oil or other combustible fluid to feed the wick or burner thereof, from a fountain, in a perpendicular direction from a reservoir beneath the flame, having the quality of burning or consuming the whole of the oil or other combustible fluid applied thereto. Dated November 2, 1809. Specification to be enrolled within two months.

DAVID MEADE RANDOLPH, a citizen of Virginia, in the United States of America, but now residing in Warwick-court, Holborn, in the county of Middlesex, Merchant; for certain improvements in the construction of wheeled

wheeled carriages of every description. Dated November 6, 1809. Specification to be enrolled within two months.

EDWARD GRIFFITH, of Birmingham, Optician; for an improved air-tight agitable lamp. Dated November 9, 1809. Specification to be enrolled within two months.

JAMES HALL, of Newbold Astbury, in the county of Chester, Book-keeper; for a method of making and manufacturing shives or shivers, and pulley wheels, of every descriptiou, and various other articles, from certain materials or compositions of earths and minerals which render the said articles more durable than such as are made in wood or metal. Dated November 14, 1809. Specification to be enrolled within two months.

ROBERT WASS, of Sheffield, in the county of York, Cutler; for certain improvements in the construction of hafts or handles for razors. Dated November 21, 1809. Specification to be enrolled within two months.

JOHN CRAGG, of Liverpool, in the county palatine of Lancaster, Esquire; for certain improvements in the casting iron roofs for houses, warehouses, and other buildings, and in covering them with slate. Dated November 21, 1809. Specification to be enrolled within two months.

JOHN TOWILL RUTT, of Basinghall-street, London, JOHN TRETTON, of Saint Andrew's-hill, and JOHN WEBB, of Clapton, in the county of Middlesex; for various improvements in the construction of machines for making cards for carding wool, cotton, flax, silk, and all substances capable of being carded. Dated November 21, 1809. Specification to be enrolled within two months.

JOHN

JOHN BROWN, of Mile End New Town, in the county of Middlesex, Stationer; for certain improvements on a machine or press for letter-press printing; and also for printing various ornaments and figures; part of which improvements may be applied to presses now in use. Dated November 28, 1809. Specification to be enrolled within two months.

WILLIAM CORNELIUS ENGLISH, of Twickenham, in the county of Middlesex, Esquire; for a method whereby heated water, steam, and air, can be rendered serviceable, and more serviceable for new purposes, and every purpose for which they have ever been applied, with less expense of fuel than is now used, especially for the purpose of working the steam-engine, and of warming and heating buildings and stoves, and also vessels and coppers for all purposes, and by which water, steam, and air (heated), may be applied to many purposes hitherto unknown. Dated November 28, 1809. Specification to be enrolled within six months.

THOMAS HERBERT, officer of the customs at the port of Malden, in the county of Essex; for a rotative pump or engine for raising and forcing air, water, and other fluids. Dated November 28, 1809. Specification to be enrolled within two months.

THE

# REPERTORY

OF

# ARTS, MANUFACTURES,

AND

# AGRICULTURE.

No. XCIII. SECOND SERIES. Feb. 1810.

*Specification of the Patent granted to* EDWARD MANLEY, *of Uffculm, in the County of Devon, Clerk; for a Plough.* Dated May 30, 1809.

With an Engraving.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Edward Manley do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained, as follows; that is to say: That in the drawing hereunto annexed (Fig. 1, Plate VII.) represents the said invention, called or known by the name of *The Expedition Plough*, which has this advantage over every other implement: that the same horse-power has more than double the effect in draught, and that the work it makes is greatly superior to that of every other plough. It is worked in a beam, in the common way,

and has three different sets of feet, which may be exchanged one for the other, as required. These are more or less in number, according to the size of the beam and the different work for which they are intended. To make the implement more generally useful, and more convenient for sale, they are so constructed that they may be all used in the following manner. The first, when set shallow in the ground, will either scarify or spine; when set deep, they will draw themselves into the ground, working it up and pulverizing it at a great depth. The second are used for the purpose of working the ground finer. The third are used for turning the ground over in single or double ridges. The beam and feet may be described as follows: the beam or wooden frame in which the feet are fixed, represents that of the common plough, with the addition of two arms or side beams to take the side feet, and is worked by handles, and set by a wheel. The feet are in three sets, as before recited: a foot of the first set represents a coulter, with a share-point, having wings fixed behind. A foot of the second set exactly resembles that of the first, but is of a smaller size. A foot of the third set differs from the others only, in that it has a single or double broad plate fixed behind the coulter. To the above implements a roller, Fig. 2, and harrow-brush, Fig. 3, are occasionally annexed.

In witness whereof, &c.

*Specification*

*Specification of the Patent granted to* JOHN BARTON, *of Argyle-street, in the Parish of St. James Westminster, in the County of Middlesex, Gentleman; for a Lamp of a new Construction, acting upon the natural unerring Principle of the Difference of Gravity between two Fluids, which produces a constant Supply of Oil or other combustible Fluid to feed the Wick or Burner thereof, founting in a perpendicular Direction from a Reservoir beneath the Flame, having the Quality of burning or consuming the Whole of the Oil or other combustible Fluid applied thereto.* Dated November 2, 1809.

With Engravings.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Barton do hereby describe and ascertain the nature of my said invention, and in what manner the same is to be performed, as follows; that is to say: My method of raising the necessary supply of oil, or other combustible fluid, in lamps, consists in applying to the bottom of the column of oil, or other combustible fluid contained in the lamp, the hydrostatic pressure of a fluid of greater specific gravity contained in an exterior reservoir, in which the lamp itself, with its contents and appendages, is made to float, and which fluid of greater specific gravity communicates with the interior of the lamp itself, and is at liberty to flow into it subject to the counteracting hydrostatic pressure of the column of oil, or other combustible fluid contained in the lamp, by means of an aperture in the bottom of it; and, with regard to this part of my invention, I am induced to believe, that by making the point at which the wick is

placed moveable, by the continual subsidence of the lamp in the exterior reservoir during the combustion of the oil, or other combustible fluid, and by the other improvements in the construction hereafter to be described, I render it unnecessary in the majority of instances to employ for the heavier fluid any one of greater specific gravity than common water, and in other respects accomplish the end proposed with greater advantage or convenience than the same has been hitherto done.

Before I proceed, however, to state more in detail the construction of my lamps, I shall endeavour, for the sake of greater perspicuity, to elucidate the principle still farther by the following example.

Let us conceive a vessel of any figure (that of a shallow cylinder or prism, whose axis is perpendicular to the horizon, may probably be the most convenient) *a b c d*, Fig. 4, (Plate VII.) having a tube *e f* open at both ends issuing centrically from its top *a b*, the bore of which is of small diameter, (as, for instance, one-tenth of an inch,) it being only necessary that it should be large enough to suffer a sufficient quantity of any combustible fluid to supply any requisite number of burners which may be connected with its superior extremity to pass freely, which tube communicates with the interior of the vessel *a b c d*, and which vessel has also the aperture *g* in its bottom. Let us now suppose this vessel to be filled with oil to *a b*, and in this state made to float in water contained in a larger vessel *h i k l*, so that the surface of the water may cut the tube *e f* at *m*, which may be effected by one or more floats, of any convenient buoyant substance, of a specific gravity considerably less than that of the fluid in which it is so made to float.

float. In the most ordinary instances the lamps themselves, which are hereafter to be described, are so made to float, by two floats, the lower one of which is constantly submerged beneath the surface of the liquor in which it so floats, and the upper of which floats with a small portion of its surface emerging above the surface of the liquor. In the annexed diagram or outline drawing, Fig. 4, we will suppose the outlines of these floats to be respectively designated by the dotted lines *p q r s* and *t u v w*. It is clear that, by this arrangement, the water in the exterior vessel will enter the vessel *a b c d* at the aperture *g*, and that the oil, impelled by its pressure upwards, will rise in the tube *e f* until its surface *n* is at a certain height above the surface of the water in the exterior vessel; that is to say, until the height of the whole column of oil is to that of its counterpoising column of water in the inverse ratio of their specific gravities: or supposing *o* to be the height to which the water rises in the vessel *a b c d*, until *n o* is to *m o* as the specific gravity of the water is to that of the oil, which we will conceive to be as 10 to 9; in which case the distance between their respective superior surfaces *m n* would be one-tenth part of *n o*, or one-ninth part of *m o*, and that the oil and water will then both become stationary, the counteracting columns of each being reciprocally equipoised. Let us now conceive, that a wick be applied either at the point *n* or within a sufficiently small distance above it for the capillary action of the cotton to draw the oil upwards to the wick copiously enough to supply its vivid combustion; we shall then see that the oil will of course gradually consume, the water again entering at the aperture *g* in the vessel *a b c d*, and its superior surface *o*, consequently rising in contact with the

the superior surface of the supernatant oil as the latter consumes, so as to supply its place; and the superior surface of the water *m* accordingly gradually subsiding in the exterior vessel *h i k l* until the contiguous surfaces of the oil and water in the vessel *a b c d* have risen to *e*, the lower extremity of the tube *e f*, and it will be equally clear, that at this period the altitude of the column of oil *m n* in the tube *e f*, which is still above the surface of the water in the exterior vessel, will remain in the same proportion to its original altitude as *o n* was to *e n*, or as *o m* was to *e m*; so that however flat the vessel *a b c d* may be, and however small the distance *a e*, if the horizontal area of the vessel *a b c d* be sufficiently large to render it capable of holding a sufficient quantity of oil to supply the burner or burners for the requisite time: the surface of the oil *n* will, during its combustion, have approached that of the water *m*, only a proportionate part of the original elevation *m n* of the oil above that of the water, and the distance *m n* between their two superior surfaces may accordingly be kept, during the combustion, indefinitely near to its original length, according to the construction of the lamp in this respect.

The part of my invention which I am now endeavouring to describe, consists in the application of the preceding principles to purposes of practical utility; and I shall therefore now proceed to describe one of the various forms of lamps which I have constructed upon such principles, and the necessary variations of which construction in the adaptation to the almost infinite variety of uses to which lamps are applicable, will be easily imagined by every able workman in their manufacture, but the whole of which will necessarily fall within the prohibition

hibition of my said patent as to this part of my said invention, if such construction be founded on the application of the before mentioned principles.

Figs. 5 and 6 in the annexed drawing, respectively, represent a perpendicular section, and an external view of a lamp of my invention, adapted for the table, or to be placed on a shelf in a hall, or on a staircase, or for any other ordinary purpose to which lamps on a stand or foot are conveniently applicable. A, Fig. 5, is a cylindrical vessel of thin brass or copper, the bottom of which *a b* is fitted on its lower extremity, either by a screw-joint or in the manner of the lid of a snuff-box, so as to be taken off at pleasure, for the purpose of cleaning the interior of the vessel A; and which bottom has an aperture in its centre C, about one-tenth of an inch in diameter. From the top of this vessel there issues the tube B communicating with it; to the superior extremity of which the burner or burners is or are adapted. The lamp here described has four; to wit, a larger one in the centre, with three smaller ones surrounding it at equal distances, forming a kind of branch or chandelier.

D, Fig. 5, is an air vessel or float, nearly, but not quite sufficiently buoyant to support the whole of the lamp itself; that is to say: the vessel A with the tube B, and the burner or burners, attached to its superior extremity in water, or such other fluid as it may be thought proper to use, for the purpose of supporting the necessary column of oil by its hydrostatic pressure, when the vessel A is filled with either oil or with such other fluid; and E is an additional float fitted on the tube B, towards its superior extremity, which is so adjusted as to be capable, together with the inferior float D, of sup-

supporting the whole of the lamp itself; that is to say: the vessel A with its tube B, and the burner or burners attached to its superior extremity when floating in water, or such other fluid as it may be thought proper to employ the hydrostatic pressure of, when the vessel A is filled with either oil or such other fluid, so as for a small portion of the upper surface of the last-mentioned float E, to appear above the surface of that fluid. It will be obvious that these floats may be made of any buoyant substance, capable of being adapted to such a purpose; as for example, of the lighter kinds of wood varnished or otherwise rendered water-tight, or cork, or they may consist of tin-plate, thin brass, or any other thin metallic plates soldered up, so as to form a hollow air-tight vessel. In the lamp which I am now describing, the lower float D, as also the upper one E, are made of cork, with a hole perforated through each of them, of such a size as to fit with a convenient degree of tightness on the outside of the tube B. It will also be evident on considering the whole construction of the lamp hereinbefore and hereinafter to be described; that it will in many instances be practicable, and in some not perhaps less convenient, to employ a single float of sufficient dimensions and buoyancy, to be fitted on that part of the tube B, where the upper float E is here represented as being placed; so as to answer the purpose of both the before-mentioned floats; but in general it will be found more convenient to use two floats, as is the case in the lamp which is here described. The exterior part of the lamp F G H I J K L M, serves to contain the fluid; by the hydrostatic pressure of which the necessary column of oil for the supply of the burner or burners, at the superior extremity of the tube

B is

B is intended to be supported, and in which the lamp itself with its tube B, the burner or burners attached to its superior extremity, and the two floats, D and E, are intended to float when the vessel A and tube B are filled, either with the oil originally introduced into it in the manner hereinafter mentioned, or with such residue of the said oil as may from time to time, during its combustion, remain unconsumed, together with such portion of the water or other fluid heavier than oil, by the hydrostatic pressure of which the column of oil is intended to be supported, as may, during the combustion of the oil, have entered the vessel A through the aperture C in its bottom, to supply the place of the oil so consumed.

In the lamp which we are now describing, there is a screw-joint at K H made water-tight, for the purpose of rendering it practicable to include in that part of it, which in the present form constitutes the base or pedestal K H J I, the vessel A, which is intended as a reservoir for the oil or other combustible liquid with which the lamp is to be supplied, and afterwards pouring on it a column of water, whose height may exceed that of the said last-mentioned joint; and the top M F of the vase M F L G ought also to fit on the vase itself by a screw or other joint, so made as to be water-tight, for the purpose of preventing the spilling of the water or other fluid heavier than oil, by the hydrostatic pressure of which the necessary column of oil is to be supported, in case it shall be necessary upon any occasion to agitate the lamp, or put it into an inclined position.

With regard to the construction of the lamp itself, with the exterior vessel which is to contain the water or other fluid heavier than oil, in which the lamp with its

contents and appendages is intended to float (except so far as relate to the form of the burner or burners hereinafter to be described), there appear to be but one or two more observations to make; the first of which is, that the whole content of the vase M F L G, at the superior extremity of the exterior vessel F G H I J K L M, ought to be such as to be equal, exclusively of the solid content of the upper float E, and that part of the tube B which passes through it, to contain a quantity of fluid very nearly but not quite equal to that which would be sufficient to fill the vessel A, which is intended as the reservoir for the oil or other combustible fluid by which the lamp is to be supplied, together with that of the tube B. It will appear upon consideration of one of the most convenient modes of filling the vessel A and tube B, with the oil or other combustible fluid by which the lamp is to be supplied, which I have thought it proper hereafter to describe; that if the whole content of the vase M F L G, exclusive of the solid content of the upper float E, and that part of the tube B, which passes through it, was considerably larger than that of the said vessel A with its tube B; the oil or other combustible fluid poured into the said last mentioned vessel through the tube B, would have expelled the whole of the water or other fluid heavier than oil, by the hydrostatic pressure of which, the necessary column of oil for the supply of the burner or burners is intended to be supported, before the vase M F L G would appear to be nearly filled with the water or other fluid heavier than oil, intended to be contained in the exterior vessel F G H I J K L M, and by the hydrostatic pressure of which, the necessary column of oil or other combustible fluid contained in the lamp itself, that is to say, in the vessel A, with its tube

tube B, is intended to be supported; and the necessary consequence would of course be, that if a larger quantity of oil or other combustible fluid was poured in through the tube B, after it had already expelled the whole of the water or other fluid heavier than oil from it and the vessel A, a portion of the oil or other combustible fluid would necessarily pass through the aperture C, in the bottom of the vessel A, and either mix itself with the water or other fluid heavier than oil, contained in the exterior vessel F G H I J K L M, or would rise through it and float on the surface of such water or other fluid heavier than oil, contained in the vase M F L G; and if on the contrary, the content of the said vase M F L G, exclusive of the solid content of the bulk of the said upper float E, was less than the solid content of the said vessel A, with its tube B, the said water or other fluid heavier than oil, would have risen to the top of the said vase M F L G, before the said vessel A would have become filled with such oil or other combustible fluid, as might be intended to supply the combustion, and a part of the content of the said vessel A would consequently be useless; or in other words, the whole of its solid content would not in such case be applicable to the purpose of containing the oil for the supply of the lamp; as a portion of it towards the bottom would still remain filled with the water or other incombustible fluid, in which the lamp with its contents and appendages was made to float.

The last circumstance with regard to the construction of the whole of the lamp and its apparatus, (except the description of the burner and its guards, which is hereinafter contained) which it appears to be necessary here to describe is, that whatever be the specific gravity of

the heavier fluid, by the hydrostatic pressure of which the column of oil or other combustible fluid for the supply of the lamp is intended to be supported, the relative heights of the whole of the vessel A, with the tube B issuing from its top, and of the branches or tubes of communication leading to the burner or burners intended to be supplied by the lamp, should be to the distance between the bottom of the vessel A, when floating with its contents and appendages in the water or other fluid heavier than oil in the exterior vessel, in a somewhat greater proportion than the inverse proportion of the specific gravities of those two fluids; so that when the vase M F L G should become filled with the water or other fluid heavier than oil, in which the lamp itself, with its contents and appendages, is made to float, the column of oil or other combustible fluid contained in the vessel A, and its tube B may be elevated in the latter, to within about an inch of the extremities of the burners; that is to say, within a sufficiently small distance of the wick, to enable the cotton to produce, by its capillary action, a sufficiently copious supply of the oil or other combustible fluid.

The practicable modes of filling the vessel or reservoir A are various; but one of the most convenient, and that which I have generally adopted, is the following: I first include the vessel A, with its tube B and float D, in the pedestal K H J I. I then screw or fit on the cover K H, with its exterior tube L G K H, and the vase M F L G at the top of it attached; and in which the tube B is intended to be included, by putting it over the said last-mentioned tube B; the float E is then put upon the tube B, and pressed down to L G; after which, I fill the said vessel K H J I and exterior tube L G K H, by

by pouring in, through the vase M F L G, a quantity of the water or other fluid heavier than oil, until the surface of such water or other fluid heavier than oil, contained in the exterior vessel, appears just above L G; that is to say, just rising into the bottom of the vase M F L G, from out of the superior extremity of the exterior tube L G K H. When it has arisen to this height, it will of course follow (as we have before supposed the vessel A and tube B to have been empty at the time of the vessel A being included in the exterior pedestal K H J I), that such water or other fluid heavier than oil, having a free passage through the aperture C; in the bottom of the said vessel A, will also have risen in the said vessel A and its tube B to the same height. I then gradually pour into the top of the tube B, the oil which is intended to supply the lamp, which as it flows down on the surface of the water or other fluid heavier than oil, by the hydrostatic pressure of which the necessary column of oil is intended to be supported, necessarily depresses it by its weight; the whole height of the column of oil from the contiguous surfaces of the oil and water, or other fluid heavier than oil, being to that of the column of such water, or other fluid heavier than oil (estimating such height in each case, from such contiguous surfaces of the oil and water, up to the surface of the water standing at the time in the exterior vessel, or up to the surface of the oil standing in the tube B respectively), in the inverse ratio of their respective specific gravities; that is to say; the perpendicular height of the column of oil which floats on the water, or other fluid heavier than oil, in the tube B and vessel A, being constantly as much greater than that of its counterpoising column of water, or other fluid heavier than

oil,

oil, by which it is supported (reckoning upwards to the surface of each from the same horizontal plane; to wit, from such contiguous surfaces of the oil and water,) as the specific gravity of the oil is less than that of the water or other fluid heavier than oil, by which it is so supported, or on the surface of which it so floats. It will be evident from the preceding description, that the surface of the oil in the tube B, will constantly rise above the level of the surface of the water, or other fluid heavier than oil, contained in the exterior vessel, as the respective lengths of the equipoised columns increase, until the tube B and the vessel A, with which it communicates, are both filled with oil; and that the oil will by its influx gradually depress the surface of the water or other fluid heavier than oil, antecedently contained in the tube B and vessel A, and force it through the aperture C, in the bottom of the latter, until the whole of such heavier fluid is driven out of the vessel A, and its place supplied by the influent oil; at which period, the contiguous surfaces will be in contact at, or close to the aperture C, and the column of oil consequently of its greatest possible height: for if more were afterwards to be poured into the tube B, a quantity of the oil itself equal to the excess, would of course protrude and make its escape from the aperture C, so as to mix with the water or other fluid heavier than oil; in the exterior vessel F G H I J K L M, through which it would rise and float on its surface. The content of the vase M F L G, at the superior extremity of the exterior vessel F G H I J K L M, or of the exterior tube L G K H, by which it is connected with the pedestal K H J I, ought however to be of such dimensions, that when the vessel A is nearly filled with the oil or other combustible fluid, with which the

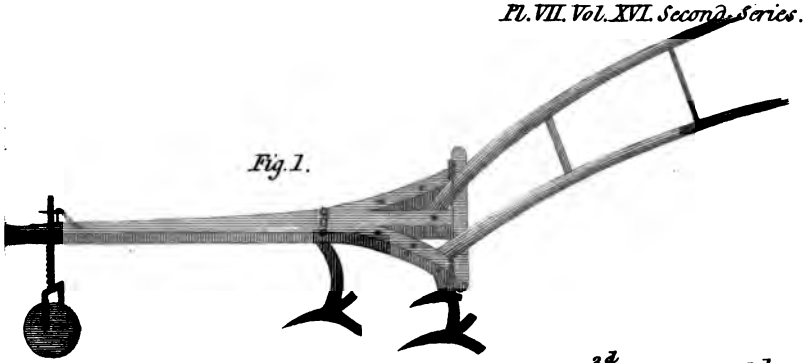
the lamp is intended to be supplied; the water or other fluid heavier than oil, with which the tube B and vessel A had been antecedently filled, and the greatest part of which will necessarily have been forced by the pressure of the superincumbent oil through the aperture C, may have caused the surface of the water or other fluid heavier than oil, in the exterior vessel F G H I J K L M, to rise very nearly to the top of the vase M F L G; by which circumstance it will of course be known, that the vessel A is then nearly filled with oil, and that it has of course become unnecessary to continue to pour in a larger quantity through the tube B, as would indeed also be indicated by the height at which the surface of the oil in the tube B would be then found to stand. All that remains to be done, will then be to screw or fit on the top M F of the vase, through the centre of which the tube B passes; to affix on the top of the tube B, the burner or burners which it is intended to feed, with the wick or wicks so inserted into them, as to extend to the depth of about an inch below the surface of the oil then standing in the tube B, so as to render it possible for the cotton, by its capillary action, to feed the flame sufficiently, and the lamp will be then ready for use.

The remaining part of my said invention, to which I have partly hereinbefore alluded, is the construction of the burner, which consists in my lamp of a tube *a b*, Fig. 7, in the annexed drawing, tapering upwards; to the upper part of which, and not more than about one-half its diameter below its superior extremity, there is attached a small plate or ledge *c d* concave upwards, and projecting on every side from the exterior of the tube itself to a distance equal to about one-half of the diameter of such tube. The intention and effect of this projecting

ing plate or ledge is to catch the small quantity of oil which generally exudes from the wick of a lamp which is sufficiently supplied, and by that means not only prevent the unpleasant effect which results from the flowing of the oil down the sides of the burner, but apply the oil, which would otherwise be wasted by this means, to the purpose of more copiously supplying the combustion of the wick. It will generally be found, when the wick is properly supplied, and this part of the burner has been well constructed, that the oil which exudes from the wick and flows into this concave ledge or receptacle will (from its natural attraction or cohesion and the consequent disposition which any small portion of it has in common with other liquids to assume a spherical form) rise in such receptacle with a convex surface somewhat similar to that with which a quantity of melted tallow or spermaceti rises in the cup surrounding the wick of a candle, which has been too shortly snuffed, until its superior surface comes into actual contact with the lower part of the wick itself, over the edge of the superior extremity of the burner, by which means the brilliancy of its light is not inconsiderably augmented. In order, however, both that no part of the oil which exudes from the wick during its combustion may be wasted, and also that the disagreeable effects which would result from its flowing down the sides of it may be still more effectually prevented, I attach to the tube which constitutes the burner, at a convenient distance below the plate or ledge, or receptacle already mentioned, a second plate or ledge, or receptacle, *e f*, of the same figure, but of larger dimensions than that above described (that is to say, whose diameter is generally to that of the upper one in the ratio of about three

to

Fig. 1.



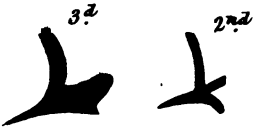



Fig. 3.

Fig. 2.

Fig. 5.

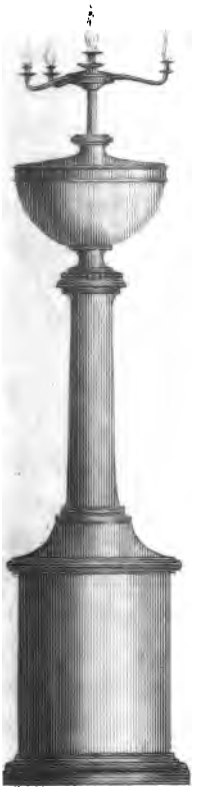


Fig. 7.

Fig. 4.

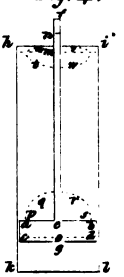



Fig. 6.

to two); and I perforate the tube, which constitutes the burner, between the said two plates, ledges or receptacles, with two or more horizontal circular rows of small apertures surrounding such tube, constituting the burner; the inferior edges of the lower row of which apertures are in contact with the upper concave surface of the lower and larger plate, ledge or receptacle *e f*, by which contrivance two effects are intended to be produced; that is to say, first, that any such oil as may escape over the edge of the upper of the said two plates, ledges or receptacles, may be caught by the lower one, and by that means again brought in contact with the wick through the said apertures; and, secondly, that the external air which is admitted through the said apertures, and a certain quantity of which will of course rise through the interstices of the cotton to the lighted portion of the wick, may assist in promoting the combustion. In witness whereof, &c.

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*Specification of the Patent granted to* WILLIAM HUTTON, *of Sheffield, in the County of York, Merchant; for a Method of making Sickles and Reaping Hooks.*

Dated July 31, 1809.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said William Hutton do hereby describe and ascertain the nature of the above invention, *(viz.* "a method of making sickles and reaping hooks, with iron or steel backs fixed upon the blades thereof, whether such blades be forged, rolled, cast, hammered, or otherwise manufactured"), and in what manner the same is to be performed, as follows; that is to say: Take a piece of

steel, hammer or roll it into a proper thickness, then cut or pare it into the form of a sickle or reaping hook: this may be called the blade of the sickle or hook: then tooth the blade, if for a sickle, in the usual manner; next harden the blade in the hardening mixture now used for saws, and give a temper or colour according to the quality of the steel of which it is made, then set and grind it. The back may be made and affixed to, or upon the blade, in manner following: take a blade made as above, pierce holes through that part intended to be affixed to the back, then take a piece of iron or steel, and hammer or draw it into the form of the back of a sickle or hook, and fit it to the blade; afterwards pierce holes in the back to correspond with those pierced in the blade, and fasten them together either with rivets or screws, or the backs may be made and fastened to the blades as follows: take a piece of iron or steel, roll, forge, cast, or hammer it to any thickness, and pare it to a breadth proper for the purpose you intend it; then double it by means of a vice, stamp, or fly-press; then fasten the tang unto or into the back, either by welding or brazing, then hammer the back upon a stithy or block of iron or steel, so that it may be flat and level, then close the edges nearly together, taking care to leave the back part more open than the edge, in order that it may form a spring for the purpose of holding itself fast to the blade; which done, put the blade into a vice, and force on the back through its nearly closed edges with a hammer, or force the blade into the back by a wooden hammer striking on the edge of the blade. In this latter mode, any number of rivets or screws may be used more effectually to fasten the back to the blade.

In witness whereof, &c.

*Specification*

*Specification of the Patent granted to* JOHN DUFF, *of Great Pulteney-street, in the County of Middlesex, Cutler; for an Invention, communicated to him by a Foreigner, of Snuffers on a new and improved Construction.* Dated December 14, 1809.

With an Engraving.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Duff do hereby declare that the said invention is fully described by the drawings in the margin of these presents, and the following description thereof; that is to say:

Fig. 1 (Plate VIII.) is a perspective view of the snuffers, with the top plate taken off to shew the work within. *a a* a scraper turning on pivots, one in the socket *b*, and the other underneath, and perpendicular to it. *c* a spring, pressing through an opening in the scraper to force it rapidly back against the valve or hanging door *d*, which has a prominent peg facing the scraper, by which it is pushed as the door *e* of the snuffers closes, and raises the valve to let the snuff pass into the receiver. It shuts again by its own weight. The scraper being of the same size as the valve or hanging door, acts as a second door to the receiver, until drawn back by opening the snuffers, and then the valve resumes its place.

Fig. 2 represents a piece of iron, which acts as a lever to draw the scraper forward and backward. Its situation is shewn by the dotted lines in Fig. 1. The crooked end of this lever is inserted in the hole *g*, Fig. 3, which is a plan of the scraper. The other end has an oval hole in it, and is held by a peg fixed in one of the shanks of the snuffers near to its left edge; and, on account of

the oval form of its aperture, draws forward the scraper at the opening of the snuffers, and pushes it backwards as the snuffers close.

The door for emptying the receiver is at the end of the snuffers, and opens and shuts by pressing the point of the snuffers upwards or downwards. This door is kept closed by an inside spring.

The two semi-oval cuts, one plain the other with a few sharp edges, on the point of the snuffers, are shewn only as a better means of raising or removing splinters or thieves in the wick of the candles, and which may or may not be added at discretion.

In witness whereof, &c.

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## *Improvements in Ship-building, by securing the Ends of the Beams of Ships without wooden Knees.*

*By Mr.* THOMAS ROBERTS, *of the Navy Office.*

With an Engraving.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

I BEG leave to send you herewith a sketch of the midship section of a 74 gun ship, showing a more effectual method of securing the beams of ships to their sides, and for superseding the necessity of standards, top and breadth riders, and nearly of wood knees altogether, which, after repeated trials, have been found fully to answer the intended purpose, and for which invention I have been rewarded with a premium of 800*l.* by the King's Order in Council of the 18th of October last, on the recommendation of the Lords of the Admiralty, and the Honourable Commissioners of His Majesty's Navy, which

which I wish to be laid before the Society of Arts, &c. if you think the merits of it worthy their notice. As the subject has not been published, I hope it will appear deserving of some mark of the Society's approbation; and in order to shew that it is not a speculative business, I beg leave to subjoin a list of ships that have been built, and are now building, agreeable to this mode.

*Built.*

| Ships' Names. | Guns. |
|---|---|
| Lively | 38 |
| Melampus | 36 |
| Jason | 32 |
| Hebe | 32 |
| Circe | 32 |
| Pallas | 32 |
| Alexandria | 32 |
| Thames | 32 |
| Resistance | 38 |
| Spartan | 38 |
| Undaunted | 38 |
| Valiant | 74 |
| Elizabeth | 74 |
| Cumberland | 74 |
| Venerable | 74 |
| Aboukir | 74 |

*Nearly complete.*

| | |
|---|---|
| Caledonia | 120 |
| Milford | 74 |
| Cornelia | 32 |
| Nereus | 32 |
| Bucephalus | 36 |
| Semiramus | 36 |
| Dolphin | 44 |

*Building.*

*Building.*

| Ships' Names. | Guns. |
|---|---|
| Ajax | 74 |
| Conquestadore | 74 |
| Vigo | 74 |
| America | 74 |
| Berwick | 74 |
| Vengeur | 74 |
| Scarborough | 74 |

REFERENCE TO THE ENGRAVINGS.

Fig. 4, (Plate VIII.) the one-half of a midship section of a large ship. A is the keel, with the false keel *a* beneath it; B the kelson; D chocks bolted thereto, to retain the opposite pieces of the riders E firmly together; F one of the orlop beams; G one of the lower deck beams, and *d* one of the upper deck beams; H are the clamps which sustain the extremities of the beams; I the floor-timbers laid across the keel and bolted to it; V the several futtocks; and W the top timbers, which are all united into one frame. K are the wooden chocks bolted to the ship's sides; and L are the iron knees, by which the beams are made fast to the chocks: these knees are also bent and bolted to the ship's sides, as shewn by L *m n* in Figs. 5 and 6. In Fig. 6, which is a plan of the beam ends, M is the outside plank, V the timbers, and *n* the filling between the timbers.

The bolts for the chocks and iron knees go through all these, as shown by the dotted lines. The dimensions of the iron knees are as follows:

Upper deck flat iron knees, breadth four inches and a half, thickness one inch.

Lower deck iron knees, breadth five inches, thickness one inch and an eighth.

Orlop,

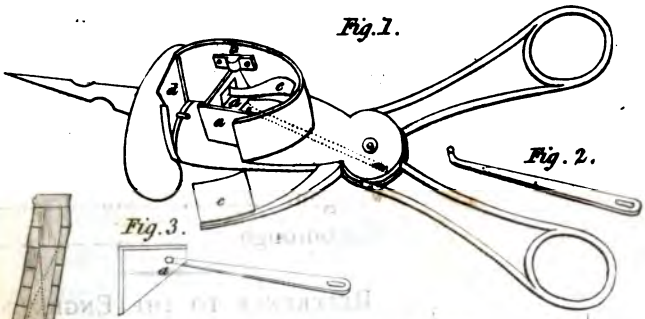
Fig. 1.
Fig. 2.
Fig. 3.

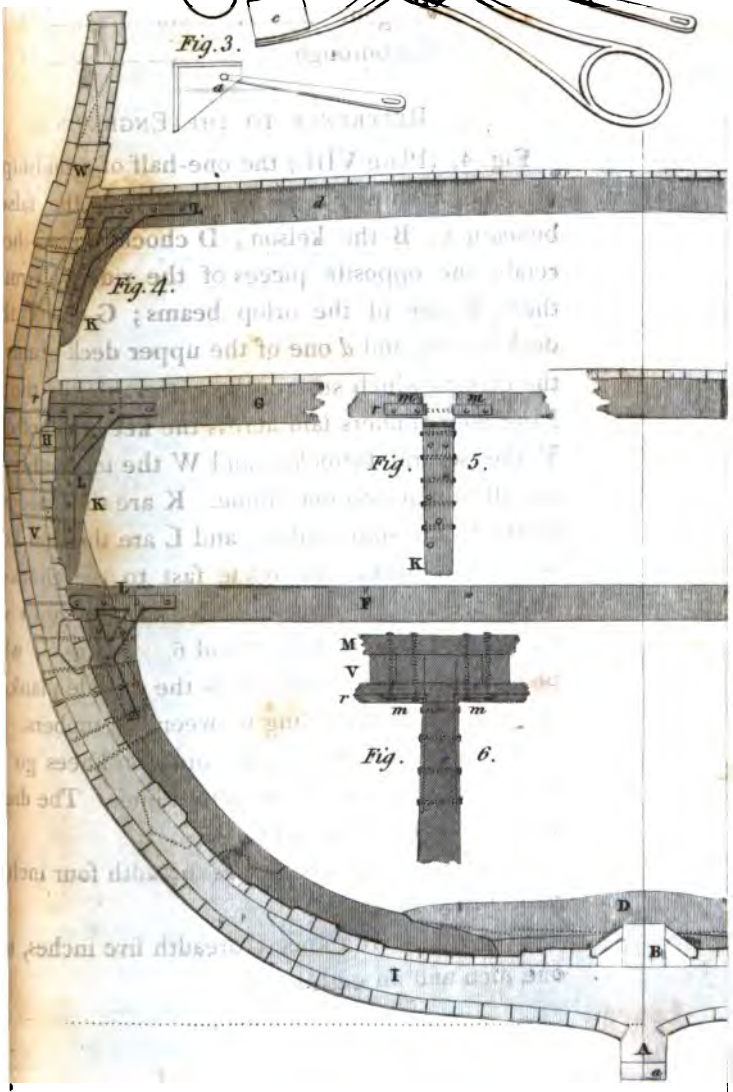
Fig. 4.
Fig. 5.
Fig. 6.

Orlop iron knees, breadth five inches, thickness one inch and an eighth.

---

*Certificates.*

We feel ourselves called upon, by a strong sense of the necessary attention due to the merit of an individual, to state to you, for the information of the Right Honourable the Lords Commissioners of the Admiralty, the great utility which has resulted to his Majesty's service, from a method of fastening the beams of ships to their sides, to which resource we have found it absolutely necessary to resort, from a general failure of the supply required of wood knees.

This contrivance is the invention of Mr. Roberts, assistant surveyor of his Majesty's navy, and has been found, after repeated trials, to answer the purpose for which it was intended. We consider it as an object of great importance in ship-building; and we therefore beg leave to recommend to their Lordships' consideration, that a premium (such as may in the judgment of their Lordships be a just reward for an invention of so much utility) be granted to Mr. Roberts, as a reward for his thus contriving a substitute so beneficial, and as an encouragement to others, to exert their inventive powers in producing works of similar worth.

THOS. B. THOMPSON.
W. RULE.
HENRY LEGGE.

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*At the Court at the Queen's Palace, the 28th October,* 1807.

PRESENT

The King's Most Excellent Majesty in Council.

Whereas there was this day read at the Board, a Memorial from the Right Honourable the Lords Commissioners

tioners of the Admiralty, dated the 27th of this instant, in the words following, *viz.*

May it please your Majesty,

The principal Officers and Commissioners of your Majesty's Navy, having represented to us, by their letter of the 27th September, 1806, that they felt themselves called upon by a strong sense of the merits of an invention of Mr. Thomas Roberts, assistant to the Surveyors of your Majesty's Navy, for fastening the beams of ships to their sides, to which expedient it was found absolutely necessary to resort, from the general failure of the supply required of wooden knees, to represent that the invention has been found, after repeated trials, to answer the purpose for which it was intended; and is considered as an object of great importance in ship-building.

And the said principal Officers and Commissioners having, by their letters of the 20th and 24th of this month, confirmed their former opinion of the utility of the contrivance, and after earnestly recommending that some reward should be granted to Mr. Roberts, set forth they are of opinion the sum of eight hundred pounds will be a proper recompense.

We have taken the same into our consideration, and concurring in opinion with the Navy Board as to the ingenuity of Mr. Roberts' invention, and the advantages that may reasonably be expected to be derived from it, do most humbly propose to your Majesty that your Majesty will be graciously pleased to authorise us to direct the Commissioners of your Majesty's Navy, to present him with a sum not exceeding eight hundred pounds, as a reward for the same.

His Majesty having taken the said memorial into consideration, was pleased, by and with the advice of his

Privy

Privy Council, to approve of what is therein proposed: —And his Majesty doth hereby authorise the Lords Commissioners of the Admiralty to direct the Commissioners of his Majesty's Navy to present the said Mr. Thomas Roberts with a sum not exceeding eight hundred pounds, as a reward for the invention.

*(A Copy.)* W. FAWKENER.

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Gentlemen,

His Majesty having been pleased, by his order in council of the 28th instant, upon our humbly laying before his Majesty the representation which you had made to us, of the merits of an invention of Mr. Thomas Roberts, assistant to the Surveyor of the Navy, for fastening the beams of ships to their sides, the utility of which invention has been found, after repeated trials, to answer the purpose for which it was intended, and is considered an object of great importance in ship-building, to direct that a sum be presented to the said Mr. Roberts, not exceeding eight hundred pounds, as a reward for his invention. We send you herewith a copy of his Majesty's order in council aforementioned, and do hereby desire and direct you, in pursuance thereof, to cause the sum of eight hundred pounds to be presented to the said Mr. Roberts, as a reward for his invention. We are, your affectionate friends,

*Admiralty Office,*
*Oct.* 30, 1808.

R. BICKERTON.
W. JOHNSTONE HOPE.
R. WARD.

*(A Copy.)*

## *On Respiration.* By WILLIAM ALLEN, *Esq. F. R. S.* and WILLIAM HASLEDINE PEPYS, *Esq. F. R. S.*

With a Plate.

From the PHILOSOPHICAL TRANSACTIONS of the ROYAL SOCIETY of LONDON.

ONE of the most prominent features in our last communication was the evolution of a considerable quantity of azote, when oxygen gas nearly pure was respired; and although a considerable part of this azote must undoubtedly be attributed to the residual gas in the lungs, after the most forcible attempt at expiration, yet the fact seemed to demand still farther investigation, it appearing of consequence to ascertain whether the increase of azote was uniform throughout the latter stages of the experiment, or *solely* confined to the earlier periods.

By adverting to our former Paper, it will be found, that in an experiment where more than 3000 cubic inches of oxygen passed through the lungs in seven minutes and a quarter, 62 cubic inches of azote were found in the first 250 cubic inches expired, though the gas originally contained but 2,5 per cent. or only 6 cubic inches in this quantity; in the two next portions expired, consisting of 562 cubic inches, we found 56 cubic inches of azote, though this quantity of gas, before it was respired, contained only 14; these, first portions, were given off in about two minutes, and contained nearly 100 cubic inches of azote more than could be accounted for in the oxygen employed; hence it is plain, that a large proportion of the increase is evolved in the first periods of the process.

Our

Our attention was particularly directed to this point in the following experiment. The oxygen, procured as usual from hyperoxygenised muriate of potash, was found to contain four per cent. of azote; the experiment was conducted in the same manner as the preceding ones, except that the tubes of the gasometers were filled with oxygen, and the gas was not merely passed *once* through the lungs, but breathed backwards and forwards. In order to prolong the duration of the experiment, which began and ended with a forcible expiration, portions of the respired gas were preserved for examination from each of the gasometers, in the following order:

| No. | |
|---|---|
| 1. | 244 |
| 2. | 294 |
| 3. | 282 |
| 4. | 266 |
| 5. | 230 |
| 6. | 266 |
| 7. | 254 |
| 8. | 288 |
| 9. | 252 |
| 10. | 168 |
| | 2544 |

The portion of oxygen remaining in the water gasometer of the original quantity, not employed in the experiment, was found upon trial to contain four per cent. of azote, as before.

*Summary of the Experiment.*

| Bar. | Therm. | Cub. Inch. of Oxygen inspired. | Cub. Inch. of Gas expired. | Deficiency. | Time. |
|---|---|---|---|---|---|
| 29,9 | 51 | 2668 | 2544 | 124 | 13 minutes: |

here the deficiency was greater than we had ever remarked before; but on passing an equal quantity of common air from the water gasometer, and registering it in the mercurial ones, we were satisfied that the apparatus was quite perfect. It is, however, to be considered, that the respiration in this case was not natural, and that some small degree of force was required when the inspirations and expirations were made in the mercurial gasometers, which renders this experiment rather different from those which had preceded it; and it appears to us probable, that a portion of air was forced into the extremities of the bronchea, which could not be suddenly expelled by the strongest attempts at expiration. Hence also, perhaps, the constant though smaller deficiency, even when the air was only once passed through the lungs; but when the process is continued for a much longer time, it is probable that the vessels recover their tone, and are able to expel nearly the whole of the volume admitted.

The air expired in the present instance, being examined in the manner described in our last paper, we found that 100 parts from each of the gasometers contained the following proportions:

No. 1.
10 carbonic acid
81 azote
9 oxygen
100

No. 2.
10 carbonic acid
11 azote
79 oxygen
100

No. 3.

| | | |
|---|---|---|
| No. 3. | 10 | carbonic acid |
| | 8,5 | azote |
| | 81,5 | oxygen |
| | 100 | |
| No. 4. | 10 | carbonic acid |
| | 7,75 | azote |
| | 82,25 | oxygen |
| | 100 | |
| No. 5. | 10 | carbonic acid |
| | 7 | azote |
| | 83 | oxygen |
| | 100 | |
| No. 6 to 10 mixed | 10,5 | carbonic acid |
| | 5,5 | azote |
| | 84 | oxygen |
| | 100 | |

we shall first calculate the total quantity of azote existing in the gas before the experiment, and afterwards estimate what was produced in the different periods during the first half of the experiment.

*Calculation for Azote.*

2668 cubic inches of oxygen were employed containing four per cent. azote: then

$$100 : 4 :: 2668 : 106,72$$

the total quantity of azote in the gas consumed, was 106,72 cubic inches.

*Azote found after the Experiments.*

| | Cubic Inches. | | | Azote found. |
|---|---|---|---|---|
| No. 1. | 244 | 100 : 21 | :: | 244 : 51,24 |
| 2. | 294 | 100 : 11 | :: | 294 : 32,34 |
| 3. | 282 | 100 : 8,5 | :: | 282 : 23,97 |
| 4. | 266 | 100 : 7,75 | :: | 266 : 20,61 |
| 5. | 230 | 100 : 7 | :: | 230 : 16,10 |
| 6 to 10. | 1228 | 100 : 5,5 | :: | 1228 : 67,54 |

Total, cubic inches, 211,80

The whole azote, found after the experiment, was - cubic inches, 211,80

Azote detected by the same tests before the experiment only - - 106,72

Increase of azote 105,08

Now, as the whole time was thirteen minutes, if we divide this by the number of gas meters filled, it will give to one minute eighteen seconds for each, and the following will be the periods in which the azote was evolved.

| | Time. | Azote found. | | Azote in the Oxygen. | | Increase. |
|---|---|---|---|---|---|---|
| No. 1. | 1.18 | 51,24 | less | 9,76 | equal to | 41,48 |
| 2. | 1.18 | 32,34 | — | 11,76 | = | 20,58 |
| 3. | 1.18 | 23,97 | — | 11,28 | = | 12,69 |
| 4. | 1.18 | 20,61 | — | 10,64 | = | 9,97 |
| 5. | 1.18 | 16,10 | — | 9,20 | = | 6,90 |
| 6 to 10. | 6.30 | 67,54 | — | 49,12 | = | 18,42 |
| | 13 min. | 211,80 | | 101,76 | | 110,04 |

Here the increase of azote appears rather greater, *viz.* 110 cubic inches, but the calculation in this case is made upon the gas *expired*, and, from the above statement, we may see, that the evolution of azote goes on diminishing;

diminishing; we have sometimes even found that towards the close of an experiment it has been almost reduced to nothing. The question now is, whether this increase of azote can be owing to the residual gas contained in the lungs at the beginning of the experiment, or whether a portion of oxygen is not actually exchanged for azote, when pure oxygen gas is respired.

Here it may be useful to compare the azote found in our former experiments on oxygen, with the present.

| | Bar. | Therm. | Oxygen Gas inspired. | Gas expired. | Deficiency. | Time. | Quantity respired in a Minute. | Inferred Capacity of Lungs. |
|---|---|---|---|---|---|---|---|---|
| No. 1. | | | 53 | 3260 | 3193 | 67 | 9,20 | 348 | 119 | 141 |
| 2. | 30,3 | 70 | 3420 | 3362 | 58 | 7,25 | 461 | 177 | 225 |
| 3. | 30,16 | 70 | 3430 | 3360 | 70 | 8,45 | 357 | 137 | 236 |
| 4. | 29,9 | 51 | 2668 | 2544 | 124 | 13 | 205 | 105 | 183 |

The greatest increase of azote was in the second experiments, when the thermometer was at 70, which might materially influence the results in the other cases, it was not higher than 58.

From the experiments of Goodwin, we might be inclined to admit the capacity of the lungs, inferred from the 1st and 4th experiments, as very possible; but it seems difficult to conceive that it can amount to 236 or 226 cubic inches, and yet this must be the case, unless a portion of azote is given off from the blood, or there is some process in nature by which it is capable of being produced from oxygen.

Having, by the kindness of our friend Henry Cline, jun. been furnished with the lungs of a stout man, about five feet ten inches high, taken from the body not long after death, and in a sound state, we proceeded to ascertain

certain the quantity of air contained in this organ after the most complete expiration, as in death.

Henry Cline had judiciously taken the precaution to divide the trachea just below the crichoid cartilage, before he opened the thorax; he then inserted a tube with a brass stop-cock, which he tied firmly to the trachea, and attached an empty bladder to the other end. The cock was then turned, so as to communicate with the bladder, and on opening the thorax 31½ cubic inches of air were expelled into it. The weight of the lungs was four pounds one ounce. A very large glass jar being placed in a shallow tin vessel, was filled to the brim with water, the lungs were then completely immersed, and the water which flowed over, and was the measure of their volume, weighed six pounds two ounces; we next cut a portion of the lungs into small pieces, under a large inverted glass of water, and attempted to squeeze the air from the cells, but although several cubic inches were thus procured, we were soon convinced that it was nearly impossible to arrive at our object by these means, as no force that we could use seemed capable of expelling the air from the cellular membrane, into which it escaped from the vesicles. We therefore took portions of the lungs, which weighed 2774 grains; the mass being put into a piece of new hair cloth, was subjected to the action of a powerful screw press, and the fluid was received in a vessel; after twice undergoing this operation, the mass weighed only 660 grains. Its specific gravity was very nearly that of water, viz. ,930 water being 1,000: the fluid procured by the press, was of the specific gravity of 1,019; this would make the specific gravity of the lungs ,997, water being 1,000; hence it appears, that the substance of the lungs, and the contents

tents of the blood-vessels together, are so near the specific gravity of water, that they may be fairly considered as the same.

Then, as the mass of the lungs was equal to 4 pounds of water, though 6,2 pounds of water were displaced by them, and as a pound of water occupies the space of 28,875 cubic inches, we have the following calculation:

| lbs. | oz. | |
|---|---|---|
| 6 | 2 | water displaced by the lungs, |
| 4 | 1 | weight of the lungs |
| 2 | 1, | or 59,554 cubic inches of air in the lungs, |
| to which | | 31,580 must be added, the volume of |
| | | the air forced into the blad- |
| | | 91,134 der on opening the thorax. |

and this gives us 91,134 cubic inches, as the air contained in the lungs of this person after death; and when we reflect that the air must have been under compression, when the lungs were immersed in water, some force being required to keep them down, and also that not less than 7 or 8 cubic inches must be contained in fauces, &c. we cannot estimate the whole at less than 100 cubic inches.

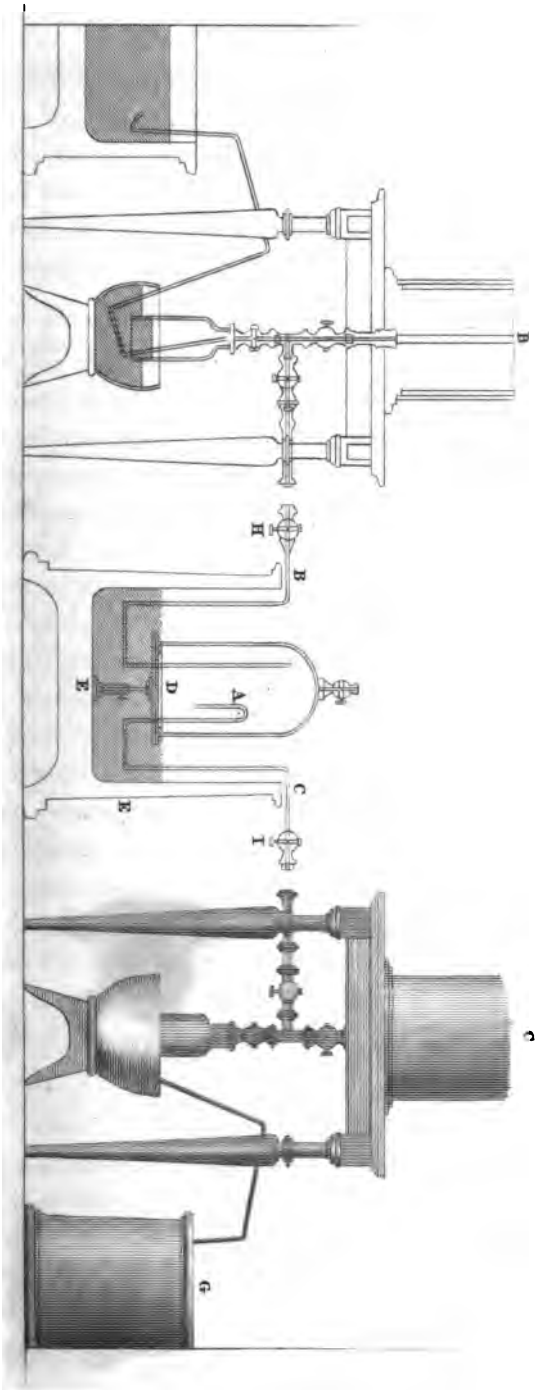
It is farther to be noted, that these 100 cubic inches would occupy much more space in the temperature of the human body, than in the mean temperature in which the examination was made; and this difference would be nearly 8 cubic inches; the air left in the lungs, after complete expiration, would therefore be 108 cubic inches; but the mean of our experiments would make it 188.

| | | |
|---|---|---|
| Experiment | 1. | 141 |
| | 2. | 225 |
| | 3. | 236 |
| | 4. | 133 |
| | | 4)735 |
| | | 183 |

we are then almost compelled to allow that when pure oxygen is respired, a portion of azote is given off from the blood.

We now resolved to perform a series of experiments upon some animal which lived wholly upon vegetable food, and made choice of the Guinea pig as one of the most manageable.

The apparatus consisted of our two large mercurial gasometers (see Plate IX.), which were made to communicate with a strong trough E, in the middle of which a small mahogany table D was made fast by a screw, for the purpose of supporting the animal under the bell-glass A; two holes were made through the table for the insertion of tubes to supply, and take off the air, each of them communicated with one of the mercurial gasometers; the tube B delivered gas towards the upper part of the glass A, in order to bring the supply of fresh air near the head of the animal: the opening of the tube C was placed within half an inch of the table to convey off the respired air; the gasometer connected with this tube, was made to communicate with a mercurial bath G, in which portions of the respired air were preserved for examination. Quicksilver being poured into the trough E, so as to rise to a level with the top of the mahogany stand, we placed a Guinea pig upon it, with the bell-glass over him, and as its edges were immersed in quicksilver,


B
H
B
E
D
A
F
C
K
I
C
G

silver, the animal was completely confined in atmospheric air: we found that his body occupied the space of 39 cubic inches, which deducted from the cubic contents of the glass A, left 55 cubic inches for the air confined with the pig, to which must be added 5 more for that contained in the tube C.

*First Experiment with Atmospheric Air.*

The pig was placed upon the stand, and the apparatus arranged as represented in the plate: 250 cubic inches of atmospheric air were admitted into the mercurial gasometer communicating with B: the gasometer communicating with C was quite empty, the apparatus being tried was found perfectly air tight, and the whole quantity of air 310 cubic inches.

The cocks H and I being opened, gentle pressure was made upon the glass of gasometer B, so as to cause the air to pass through A, which consequently drove an equal portion through the tube C into the empty gasometer: a quarter of an hour was employed in passing the gas, which measured exactly 250 cubic inches in C, so that there was no alteration of volume; the cocks H and I were now closed, and the respired air being examined by the usual methods, 100 parts were found to contain

5 carbonic acid
16 oxygen
79 azote

100

As the air after the experiment had experienced no alteration of volume, and as it contained the same proportion of azote as atmospheric air, this substance had remained

mained unaltered. But 15,50 cubic inches of oxygen had been converted into carbonic acid gas.

100 : 5 : : 310 : 15,50.

*Summary of the Experiment.*

| Bar. | Therm. | Atmos. air inspired. | Gas after experiment. | Cub. inches of carb. acid. | Cub. in. of carb. acid per minute. | Time. |
|---|---|---|---|---|---|---|
| 30° | 43° | 310 | 310 | 15,5 | ,62 | 25 min. |

*Experiment* II. *Atmospheric Air.*

The experiment was repeated in exactly the same manner; the animal, except from confinement, appeared much at his ease all the time. The air after the experiment contained in 100 parts

5,5 carbonic acid
15,5 oxygen
79 azote
100

here the proportions of azote were undisturbed, and 17,05 cubic inches of carbonic acid procured.

100 : 5,5 : : 310 : : 17,05

*Summary of the Experiment.*

| Bar. | Therm. | Atmos. air inspired. | Air after experiment. | Carb. acid found. | Carb. acid per minute. | Time. |
|---|---|---|---|---|---|---|
| 29,66 | 3°. | 310. | 3510 | 17,05 | ,68 | 25 min. |

*Experiment* III. *Atmospheric Air.*

The apparatus being arranged as before, we kept the pig in the glass A for one hour, and during that time passed 1000 cubic inches of atmospheric air through it, which measured 1001; portions of the respired gas had been preserved in the mercurial bath, and the usual trials made upon the mixture, which was found to contain

tain 5 parts of carbonic acid in every 100, or 53 cubic inches in the whole quantity; the azote was unaltered;

100 : 5 : : 1060 : 53.

*Summary of the Experiment.*

| Bar. | Therm. | Atmos. air before expt. | Air after expt. | Increase. | Carb. acid found. | Carb. acid per min. | Time. |
|---|---|---|---|---|---|---|---|
| 29,8 | 56° | 1060. | 1061 | 1 | 53 | ,88 | 1 hr. |

*Experiment* IV. *Oxygen Gas.*

The pig hitherto employed was put into the glass vessel A, which with the tube contained 60 cubic inches of atmospheric air; 250 cubic inches of oxygen, containing 5 per cent. of azote, were admitted into the gasometer communicating with B, and during a quarter of an hour were made to pass slowly through the vessel in which the animal was confined, to the empty gasometer communicating with C, where it measured exactly 250 cubic inches; a portion was preserved in the mercurial bath for examination, and the gasometer B was replenished with 250 cubic inches of the same oxygen; this was passed in about the same time as before, through A into gasometer C, when it measured 248 cubic inches.

250 cubic inches more of the oxygen were now admitted into gasometer B, and passed in the same manner through A into C, where they measured 249.

The gasometer B was for the fourth and last time supplied with 250 cubic inches more of the oxygen, which were passed as before, through A into C, during about a quarter of an hour, and then measured 249.

The pig had remained in the vessel one hour and twelve minutes; it did not appear to have suffered in the least; portions of the respired gas were saved from each of the gasometers, and examined as usual.

No.

| | Cubic Inches. | Contained in 1000 parts, | Carb. Acid. | Oxygen. | Azote. |
|---|---|---|---|---|---|
| No. 1. | 250 | Carb. acid 8 | 20 | | |
| | | Oxygen 66 | | 165 | |
| | | Azote 26 | | | 65 |
| | | 100 | | | |
| No. 2. | 248 | Carb. acid 10 | 24,80 | | |
| | | Oxygen 78 | | 193,44 | |
| | | Azote 12 | | | 29,76 |
| | | 100 | | | |
| No. 3. | 249 | Carb. acid 10 | 24,90 | | |
| | | Oxygen 80 | | 199,20 | |
| | | Azote 10 | | | 24,90 |
| | | 100 | | | |
| No. 4. | 249 | Carb. acid 12 | 29,88 | | |
| | | Oxygen 79 | | 196,71 | |
| | | Azote 9 | | | 22,41 |
| | | 100 | | | |
| In Glass A. and tube C. | 60 | Carb. acid 12 | 7,20 | | |
| | | Oxygen 79 | | 47,40 | |
| | | Azote 9 | | | 5,45 |
| | 1056 | 100 | 106,78 | 801,75 | 147,52 |

Total, gas before experiment, 1060

after 1056

Deficiency, 4

Cal.

*Calculation for Oxygen.*

We do not calculate upon the tube from gasometer B, because it is always in the same state after the experiment as before.

| | | |
|---|---|---|
| 1000 cubic inches of oxygen containing 5 per cent. azote, consisted of | 950 | pure oxygen |
| 60 Atmospheric air with the pig, and in tube C, containing 21 per cent. oxygen | 12,60 | |
| Total, oxygen before experiment, | 962,60 | |
| Oxygen found after experiment, - | 801,75 | |
| Ditto in carbonic acid | 106,78 | |
| | 908,53 | |
| Oxygen missing, - | 54,07 | |

*Calculation for Azote.*

| | |
|---|---|
| 1000 cubic inches containing 5 per cent. azote - - - | 50 |
| 60 Atmospheric air, containing 79 per cent. - - - | 47,40 |
| Total azote before experiment, | 97,40 |
| Ditto found after experiment, | 147,52 |
| Increase of azote, - | 50,12 |

This increase of azote was much more than equal to the cubic contents of the animal's body; the deficiency of 4 cubic inches was doubtless oxygen absorbed.

*Summary of the Experiment.*

| Bar. | Therm. | Oxygen, &c. inspired. | Gas after experiment. | Deficiency. | Carb. acid found. | Carb. acid per min. | Time. h ′ | Oxygen missing. | Azote added. |
|---|---|---|---|---|---|---|---|---|---|
| 29,05 | 57 | 1060 | 1056 | 4 | 106 | 1,48 | 1 12 | 54,07 | 50,12 |

*Ex-*

*Experiment V. Oxygen.*

In this experiment we employed a smaller pig, which occupied the space of 33 cubic inches; and our object was to keep him for the same length of time in a smaller quantity of gas; we therefore only used 750 cubic inches of oxygen, beside the common air contained in the glass A, and tube, amounting to 66 cubic inches; the first 250 cubic inches were passed through the glass A into C in 24 minutes, where it appeared to have undergone no alteration of volume. 250 cubic inches more were passed during the next 23 minutes, and these measured 248 in C; the last 250 were passed in 24 minutes, and the volume remained unaltered. The animal did not appear to suffer the slightest inconvenience, except from the confinement.

*State of the Gas before Respiration.*

| | | Oxygen. | Azote. |
|---|---|---|---|
| 66 cubic inches of atmospheric air, | = | 13,86 | 52,14 |
| 750 oxygen, containing 5 per cent. azote, | = | 712,50 | 37,50 |
| 816 total consisting of | | 726,36 | 89,64 |

The oxygen was tried before, as well as after the experiment, and both the results agreed perfectly with each other. We now examined portions of gas preserved from the three gasometers, with lime water, and the tests for oxygen.

No.

| | Time. | Contained in 100 parts. | | Carbonic acid. | Oxygen. | Azote. |
|---|---|---|---|---|---|---|
| No. 1. 250. | 24 | Carb. acid | 9,5 | 23,75 | | |
| | | Oxygen | 60,5 | | 151,25 | |
| | | Azote | 30 | | | 75 |
| | | | 100 | | | |
| No. 2. 248. | 23 | Carb. acid | 9,5 | 23,56 | | |
| | | Oxygen | 81 | | 200,88 | |
| | | Azote | 9,5 | | | 23,56 |
| | | | 100 | | | |
| No. 3. 250. | 24 | Carb. acid | 10,25 | | | |
| | | Oxygen | 82 | | 205 | |
| | | Azote | 8 | | | 20 |
| | | | 100 | | | |
| 66 with pig, as No. 3. | | | | 6,60 | 54,12 | 5,28 |
| 814 | 71 | | | 78,91 | 611,25 | 123,84 |

*Calculation for Oxygen.*

| | | |
|---|---|---|
| Oxygen before the experiment | | 726,36 |
| Ditto after | 611,25 | |
| In carbonic acid | 78,91 | |
| | 690,16 | |
| Loss of oxygen | | 36,20 |

*Calculation for Azote.*

| | | |
|---|---|---|
| Azote found after experiment | | 123,84 |
| Ditto before experiment | | 89,64 |
| Increase of azote | | 34,20 |

*Summary of the Experiment.*

| Ther. | Gas before Exper. | Gas after Exper. | Deficiency. | Carbonic Acid found. | Cubic Inches per Minute. | Time. | Oxygen missing. | Azote added. |
|---|---|---|---|---|---|---|---|---|
| ° | | | | | | h ″ | | |
| 56 | 816 | 814 | 2 | 78,91 | 1,11 | 1 11 | 36,20 | 34,20 |

The quantity of azote added, of oxygen missing, and of carbonic acid formed, were smaller than in the last experiment; but the animal in this instance was smaller, as well as the quantity of oxygen passed through in a given time.

In this case, as in the human subject, the increase of azote takes place principally in the early periods. The whole azote contained in the 66 cubic inches, confined with the pig, was only 52,14; but supposing, which perhaps was not the case, that the 66 of common air were expelled by the first 250 cubic inches of oxygen, we should have 250

less 66

184 of oxygen,

containing 5 per cent. azote, or 9,20 cubic inches; these added to the 52,14, would make 61,34 of azote to be found in the first gasometer of respired gas; but we detected 75, so that even on this supposition 13,66 of azote were added in the first twenty-four minutes.

The azote contained in the second gasometer before respiration was 12,50 cubic inches; but after it had been respired for twenty-three minutes we found 23,75, or an increase of 11,25 azote. The azote contained in the third gasometer, before respiration, was, as before, 12,50 cubic inches; but after it had been respired for twenty-four minutes we found 20, or an increase of 7,50 azote.

The

The azote contained in the 66 cubic inches, was 3,30, but we found 5,28, or an increase of 1,98 azote.

From the results of these experiments, it seemed that when the *usual proportion* of azote was not present in the gas respired, there was a disposition in the blood to give out a certain quantity in exchange for an equal volume of oxygen, and we resolved to try, whether this circumstance would occur when hydrogen was substituted for azote: we accordingly made a mixture containing 22 per cent. oxygen and 78 hydrogen.

*Experiment* 6. *Hydrogen and Oxygen.*

The pig employed in the last experiment was placed upon the stand in the glass A, with 66 cubic inches of common air as usual.

250 cubic inches of the mixture were passed from the gasometer, communicating with B through the glass A into the gasometer communicating with C during sixteen minutes. The animal did not appear uneasy: a second quantity of 250 cubic inches was passed in seventeen minutes and three quarters: the animal did not seem to be in the least incommoded.

A third quantity of 250 cubic inches was passed in about sixteen minutes.

And a fourth quantity of 250 cubic inches in eleven minutes and three quarters; but during this time the animal became very sleepy, and towards the end of the experiment kept his eyes constantly shut; he, however, appeared to suffer nothing, and was easily roused for a short time by rapping at the side of the glass. At the end of sixty-one minutes and a half he was taken out, and we found that during this time he had produced

60,20 cubic inches of carbonic acid gas, or rather less than one cubic inch in a minute.

It appears that less carbonic acid was evolved in this instance in a given time than when oxygen was respired, but some circumstances occurred to prevent us from discovering what change the azote had experienced: this point was, however, decided by the following experiment.

*Experiment* 7. *Hydrogen and Oxygen.*

Having mixed hydrogen and oxygen gases in such proportion as that the oxygen should rather exceed the quantity contained in atmospheric air, we placed the same animal in the glass A with 66. cubic inches of atmospheric air, 250 cubic inches of the mixture were admitted into gasometer B, from the large water gasometer, and gradually passed through the glass A into gasometer C, during fifteen minutes. The pig did not appear uneasy, and the respired gas measured 250 in C: a portion of this was preserved for examination, which we shall call No. 1.

250 cubic inches more of the mixture were admitted into B, and gradually passed, as before, during thirteen minutes; it measured 250 in C; and a portion No. 2 was preserved for examination.

The animal did not seem to suffer any inconvenience. 250 cubic inches more of the mixture were admitted into B, and gradually passed, as before, through A into C during seventeen minutes. The animal now become quite sleepy, but did not appear to suffer any thing. He was taken out at the end of forty minutes.

At the close of the experiment the remains of the mixture, which had stood about an hour in the large water

water gasometer, being examined, was found to contain 22 per cent. of oxygen and no carbonic acid; of the residual 78 parts, 20 were mixed with 10 of oxygen, which had been previously found to contain 3 per cent. azote; these 30 parts being detonated in Davy's improved Volta's eudiometer, by the electric spark, were reduced to 3 parts, and these 3 parts being treated with the tests of oxygen, were reduced to 2 parts, *a proof that all the hydrogen had been consumed;* but the 10 parts of oxygen contained 3 of azote; this deducted from 2, leaves 1,7 for the azote contained in 20 parts of the residuum 78.

20 : 1,7 : : 78 : 6,6

The mixture employed, therefore, contained in every 100 parts

22 oxygen
6,6 azote
71,4 hydrogen

100

We next examined the gas which had been respired.

No. 1. 250 cubic inches respired during fifteen minutes.

100 parts, subjected to the action of lime-water in Pepys's eudiometer, were reduced to 93,5, and this by the tests for oxygen was farther diminished to 77 : 20 parts of this 77, mixed with 10 of oxygen and detonated; the residuum treated with the tests for oxygen, left 12 parts which were azote.

From these 12 parts
Deduct ,3 for the azote in the 10 parts oxygen

Leaves 11,7 for the azote contained in 20 parts of the residual 77.

No.

20 : 11,7 : : 77 : 45

No. 1. therefore consisted in 100 parts of

6,5 carbonic acid
16,5 oxygen
45 azote
32 hydrogen

100

No. 2. 250. Respired during thirteen minutes; 100 parts were reduced by lime water to 92,5, and these by the tests for oxygen to 77. Of these 77 parts, 20 being mixed with 10 of oxygen, and detonated, were diminished to 4, and these 4 being examined for oxygen left 3, which must be azote:

From these 3
Deduct ,3 for azote in the 10 parts oxygen.

Leaves 2,7 for the azote contained in 20 parts of the residual 77.

20 : 2,7 : : 77 : 10,4

No. 2. therefore consisted in 100 parts, of

7,5 carbonic acid
15,5 oxygen
10,4 azote
66,6 hydrogen

100

No. 3. 250. respired during seventeen minutes; examined as above, consisted in 100 parts, of

6 carbonic acid
17 oxygen
6,5 azote
70,5 hydrogen

100

the

the 66 remaining with the animal at the close of the experiment, may be considered as very nearly the same as No. 3.

In this, as in the former experiment, we observed that the evolution of carbonic acid was greatest at the middle of the time, but was considerably diminished toward the end, as the pig became sleepy; it is not improbable therefore, that during sleep, less carbonic acid is evolved than when the animal is exercising all its faculties.

When atmospheric air alone is respired, we have uniformly found, that the carbonic acid evolved, added to the oxygen remaining, exactly equalled the oxygen existing in the air before it was respired, but in the present instance it was one per cent. more, a circumstance which we are at present unable to account for; but it was constantly the case in all the three trials.

*Calculation for Azote.*

From the foregoing statement we are enabled to ascertain the quantities of azote, both before and after the experiment.

*Azote before the Experiment.*

66 cub. inches atmospheric air, with the animal contained $\frac{79}{100}$ or ..... 52,14

750 ——— of the mixed gasses contained $\frac{79}{100}$ or 49,50

816 total gas employed ..... 101,64

The total azote before the experiment was therefore 101,64 cubic inches.

*Azote*

*Azote after the Experiment.*

| | | Respired during | | |
|---|---|---|---|---|
| No. 1. | 250. | 15 min. | 100 : 45 : : 250 : | 112,50 |
| 2. | 250. | 13 min. | 100 : 10,4 : : 250 : | 26 |
| 3. | 250. | 17 min. | 100 : 6,5 : : 250 : | 16,25 |
| | 66. | | 100 : 6,5 : : 66 . | 4,29 |
| | 816 | 45 min. | Azote after experiment | 159,04 |
| | | | Ditto before | 101,64 |
| | | | Increase of Azote | 57,40 |

*Calculation for Hydrogen.*

*Hydrogen before Experiment.*

The mixture before the experiment was found to contain 71,4 hydrogen,

100 : 71,4 : : 750 : 535,50

therefore the total quantity must be 535,50 cubic inches.

*Hydrogen after Experiment.*

| | | | |
|---|---|---|---|
| No. 1. | 250 | 100 : 32 : : 250 : | 80 |
| 2. | 250 | 100 : 66,6 : : 250 : | 166,50 |
| 3. | 250 | 100 : 70,5 : : 250 : | 176,25 |
| | 66 in A | 100 : 70,5 : : 66 : | 46,53 |
| | | Hydrogen found after experiment | 469,28 |
| | | Hydrogen before the experiment | 535,50 |
| | | Ditto after | 469,28 |
| | | Loss of hydrogen | 66,22 |

In this experiment, as well as in those with oxygen, the proportion of azote evolved was greater in the early than in

in the later periods, and it becomes interesting to contrast them: thus we know that 52,14 cubic inches of azote were in the vessel with the animal at the beginning of the experiment, and that, of the 250 cubic inches of mixed gases passed in the first fifteen minutes, only 184 could be expelled into gasometer C, (100 : 6,6 ; : 184 : 12,14.) which contained only ..... 12,14

making together ..... 64,28 of azote, which was all that could have been expected in the first gasometer of 250 after respiration, supposing the *whole* of the common air had been expelled; but we detected 112,50, or an increase of 48,22 cubic inches in fifteen minutes.

The second gasometer before it was connected with the glass A, contained but 16,50 cubic inches of azote; we found however about 26, and what is remarkable, in the last gasometer there was no increase at all.

*Calculation for Carbonic Acid.*

| | | | | |
|---|---|---|---|---|
| No. 1. | 250. | 15 min. | 100 : 6,5 : : 250 : | 16,25 |
| 2. | 250. | 13 min. | 100 : 7,5 : : 250 : | 18,75 |
| 3. | 250. | 17 min. | 100 : 6 : : 250 : | 15 |
| | 66. | | 100 : 6 : : 66 : | 3,96 |
| | 45 | | | 53,96 |

The quantity of carbonic acid evolved in 45 minutes was therefore 53,96 cubic inches, or at the rate of 1,19 cubic inches per minute.

The foregoing experiments seem to prove,

1. That when atmospheric air alone is respired, even by an animal subsisting wholly upon vegetables, no other change takes place in it, than the substitution of a certain portion of carbonic acid gas, for an equal volume of oxygen.

2. That when nearly pure oxygen gas is respired, a portion of it is missing at the end of the experiment, and its place supplied by a corresponding quantity of azote; the portion evolved in a given time, being greater in the early than in the later periods.

3. That the same thing takes place when an animal is made to breathe a mixture of hydrogen and oxygen, in which the former is in nearly the same proportion to the latter, as azote to oxygen in atmospheric air.

4. That an animal is capable of breathing a mixture of 78 parts hydrogen, and 22 oxygen for more than an hour, without suffering any apparent inconvenience.

5. That the excitability of an animal is much diminished when he breathes any considerable proportion of hydrogen gas, or that it at least has a tendency to produce sleep.

6. That there is reason to presume an animal evolves less carbonic acid gas during its sleeping, than in its waking hours.

7. That the lungs of a middle sized man contain more than 100 cubic inches of air after death.

These experiments have been conducted without reference to any particular theory, and indeed some of the results were so contrary to our preconceived opinions, that we have been induced to bestow more than ordinary attention on the subject. Confident, however, that all those

those who repeat the experiments with the same care will arrive at the same results, we shall rest satisfied with stating the facts, not without a hope that those brilliant discoveries of Professor Davy, which have already given us new views of the operations of nature, will in their progress furnish us with that explanation which it is in vain to expect at present.

Azote or nitrogen, for instance, has been considered as a simple or elementary substance; it is recognised, however, principally by negative properties. Every gaseous fluid which will not support life or combustion, which is not absorbed by water, nor acted upon by the tests for oxygen, nor capable of being detonated with oxygen gas, is generally pronounced to be azote: it is the constant residuum in almost all our experiments upon gases, but who shall say whether this residuum is a simple substance or a compound?

The experiment of Professor Berzelius, leads us to suspect it of metallic properties; and those of Davy make it probable that it is an oxydated body; the subject is still under discussion. But we may fairly indulge more than a hope that the ardent zeal, and well directed labours of the philosophers just mentioned, will throw a new and important light upon this obscure and difficult subject.

## *On the Action of Phosphorus and oxymuriatic acid Gas upon alkaline Substances.*

*By Messrs.* BOUILLON LAGRANGE, *and* VOGEL.

(Concluded from Page 118.)

WHEN the retort was completely cold it was broke. A black mass was found in it. The internal part of the retort was entirely covered with a brilliant coating, of a metallic appearance, and looking like carburet of iron.

The black substance had a slightly alkaline taste: it was but little soluble in cold water; but, on boiling the water, it was all taken up except a black powder which precipitated. Boiling nitric acid also dissolved it, and in like manner separated a black substance, which was only oxyd of carbon.

The watery or nitric solution contains only phosphate of potash.

In the numerous experiments that have been made in this manner, there was one in which the black mass was obtained without any sensible taste. Water had no action upon it. Nitric acid dissolved it, and separated from it oxyd of carbon. The part of the tube communicating with the retort was lined with a grayish substance, that took fire by the contact of the air. As to the salt that remained in the retort, it was nothing but neutral phosphate of potash, which, as is well known, is nearly insoluble in water.

In the course of these experiments, potash and soda was alternately made use of; and instead of a stone-ware retort, a porcelain tube and retort were used. The results were, however, similar.

The

The properties exhibited by the above-mentioned gas are,

1°. To be neither acid nor alkaline.

2°. To have a slight smell of garlic.

3°. To take fire with a white flame by bringing a taper near it; and to yield by this combustion, a little phosphoric acid and oxyd of phosphorus.

4°. To detonate strongly when, after being mixed with oxygen, an ignited substance is brought into contact with it.

5°. Not to take fire by mere contact of common air, nor of oxygen, nor of nitrous gas.

6°. To be slightly soluble in water; and then nitrate of silver produces a blackish precipitate in the water.

7°. To take fire with rapidity when mixed with oxy-muriatic acid gas, and to deposit a little oxyd of phosphorus upon the sides of the bell-glass.

This elastic fluid may be procured by a simple and easy process. It is only necessary to put a little very dry phosphorus cut into small pieces into an apothecaries' phial, to sprinkle it with some very dry caustic potash, and to adapt to the phial a bent tube, communicating with a mercurial apparatus. On heating the phial slightly white vapours appear, but no flame, and the gas is emitted. The temperature is gradually raised until no more bubbles are disengaged. A black substance, rather alkaline, containing phosphate of potash, remains in the phial.

When a little water is added to the mixture, there is a great difference. So long as any moisture remains in it, phosphuretted hydrogen is obtained, which takes fire by the contact of the air; but as soon as the matter is dry, if the action of the fire be continued, the gas which

is

is disengaged no longer takes fire by the contact of air; and it has all the properties of the above-mentioned gas.

This difference in the results doubtless merits a farther examination, and perhaps cannot be explained without starting some hypothesis. The following experiment is in the same case; and this experiment may throw some light upon the above-mentioned phenomena.

Two drachms of pure potash were introduced into a porcelain tube, which was placed across a reverberatory furnace. The tube being heated to whiteness, oxymuriatic acid gas disengaged from a matras in which a proper mixture had been made, was passed through it. An intermediate bottle, without water, received the gas before it went into the porcelain tube; the other extremity of this tube was connected with a pneumato-chemical apparatus.

The instant that the oxymuriatic acid gas touched the potash, there passed under the bell-glass a great deal of water, in vapour, that was difficultly condensed. It left on condensation carbonic acid gas. Some time afterwards oxymuriatic acid gas appeared in the bell-glass. It was examined, and it yielded an abundant precipitate with lime-water, and barytes water, which it was necessary to add in excess. Towards the end of the operation oxymuriatic acid gas was no longer emitted, but a mixture of oxygen and carbonic acid gas.

Carbonic acid gas was therefore disengaged during the whole course of the operation; this disengagement took place at three different periods: first, along with the water in vapour; secondly, along with the oxymuriatic gas; thirdly, along with the oxygen. All these

gases

gases were cloudy, and only became transparent by solution in water.

The quantity of carbonic acid gas that was collected and separated appeared to be too considerable to be attributed to the acid that was retained by the potash. Besides, the alkali which was used was purified with great care; and the acid that was retained in it, for in spite of every precaution the acid could not be entirely separated, could only be recognised by barytes-water, which, however, only acquired a slight cloudiness scarcely perceptible.

And again, it was not intended, nor was it even possible, to establish and determine the constituent parts of potash. But from these experiments it would appear that hydrogen and carbon exist in some certain proportion in this alkali.

Muriate of potash, in thin white flakes, slightly adhering, was found in the porcelain tube. Some of it was of a clear green colour. The weight of this salt was much less than that of the potash that was used.

It appears, therefore, that all these experiments, although but of little importance, may induce a more attentive examination of the changes that take place in substances which are exposed to different temperatures, at the very time when other bodies are brought into contact with them.

The action of oxygen and hydrogen upon potash has also produced some phenomena, of which an account will hereafter be given.

On

## *On the Decomposition of Water by Charcoal.*

*By M.* TORDEUX.

From the ANNALES DE CHIMIE.

IN a note at the end of M. Figuier's paper on the sulphurets which are contained in soda (Ann. de Chim. No. 195.) M. Figuier mentions an example of the explosions which sometimes happen in soap manufactories. He attributes them to hydrogen mixed with atmospheric air existing in the internal part of the cistern, above the caustic ley, and he explains the formation of the hydrogen, by supposing that the sulphurets which the common soda contains, disengage, when water is added, a greater quantity of hydrogen than is necessary to constitute hydroguretted sulphuret.

It is known to chemists, that when an alkaline sulphuret is put into water, it is partly decomposed: a sulphate is formed, and the hydrogen that is separated, combines with the remainder of the sulphur, and of the base, and forms a hydroguretted sulphuret; it is also known, that if the operation is performed at a low temperature, no gas is emitted.

It is evident from this, that the hydrogen which lies upon the soap-maker's ley, does not arise from the decomposition of water, by the alkaline sulphuret.

The production of this gas may probably be attributed to the charcoal which is always contained in the common soda, from an observation which occurred several months ago. Potash purified by lime, which had been for some time in contact with vegetable substances, and was highly coloured by the carbonaceous substances, which

it

it had taken from them, being melted in a crucible, as soon as the alkali was ignited a considerable quantity of gas escaped, that took fire of itself, and burned like hydrogen gas.

From what is said by M. Figuier in his memoir, it would appear, that the hydrogen of which he speaks is produced by a similar cause. Several experiments were made to ascertain this point; the results of which will be detailed in the present paper.

The potash upon which the original observation had been made, contained, besides the carbonaceous matter, a quantity of water, which was in the greater proportion as the potash had not been ignited during the drying. And the circumstances being favourable, it appeared that the carbonic acid might perhaps be formed in this case by the simultaneous attraction of charcoal for oxygen, and of potash for the acid; and that the hydrogen of course was disengaged either pure or carburetted.

In order to ascertain this fact, potash, similar to that which had been heated in the crucible, was distilled in a stone-ware retort: as soon as the heat was sufficient to separate the water from the potash, a gas was emitted, which continued to be disengaged during part of the operation. This gas was insoluble in water: it had a weak empyreumatic smell: it did not render lime-water turbid: it was inflammable, and burned like a mixture of hydrogen and carburetted hydrogen: after combustion, it rendered lime-water turbid; being mixed with oxygen, it detonated by the electric spark.

This disengagement of gas continued for a long time by a weak heat; nevertheless the fire was augmented until the bottom of the retort was red; and the same

produce was always obtained, only the hydrogen was purer than before.

After some time, the emission slackened, the fire was augmented, and when the retort was thoroughly ignited, the emission began afresh; but the gas which was now disengaged was entirely absorbed by water, or by lime-water, which it rendered turbid: it was no longer inflammable; it was in fact pure carbonic acid. Nevertheless, at the end of the operation it left a combustible residuum when it was agitated with lime-water; this residuum was probably gaseous oxyd of carbone. The potash was become nearly white, and the retort was attacked.

It appeared that this operation may be explained in the following manner. Water in contact with charcoal and potash acts the same as when it is in contact with an alkaline sulphuret or phosphuret: carbonic acid is formed and a carbonate, as potash which has been purified by lime can retain at that temperature a much larger quantity of carbonic acid than it previously contained: and if when the retort is ignited, that acid is disengaged, this emission is probably owing to the combination of the potash with the earthy matters of the retort; a combination that does not admit the presence of carbonic acid. Lastly, the gaseous oxyd of carbone is doubtless formed from the decomposition of a little of the carbonic acid by some remains of the charcoal.

This experiment has been confirmed by another made upon some potash combined with a considerable quantity of charcoal and carbonic acid, which was obtained in the following manner: alkohol which contained a considerable quantity of potash in solution, was clear but very high coloured, and that did not effervesce with acids,

was

was evaporated to dryness. This evaporation was performed in a silver basin in order to obtain the potash in a pure state: as the operation went on, the potash became very dark coloured; and towards the end, it puffed up, and allowed an inflammable gas to be disengaged: at last it became dry and spongy: it was treated with water, and evaporated to dryness without being filtered: it became black like charcoal, and effervesced a little.

In this state it was distilled in a stone-ware retort, in the same manner as the potash purified by lime had been; the result of the operation was exactly the same; when the potash was taken out of the retort, it was white and produced an effervescence.

It is very probable that the same results would have been obtained from soda purified by lime, if it had been submitted to the same experiments, considering the great resemblance that exists between the two alkalies.

In order to render the experiments somewhat similar to that which takes place in the soap-manufactories, it remained to form a caustic ley as made by the soap-boilers, and to examine what passed in this operation. A paste was made with 500 grammes (1 lb. av.) of pulverised Alicant soda, and 250 gr. (half a lb.) of lime lately slacked; it was diluted with water, and left for 10 or 12 days, in a convenient apparatus, at the temperature of 10 to 15° (Cels. 50 to 59° Fahr.) It did not disengage any gas, but some bubbles of azote. Although the result of this experiment did not afford any satisfaction, yet it may not be less true that the hydrogen, whether pure or carburetted, which is produced in the soap works, does in fact arise, as mentioned above, from the decomposition of water by charcoal. In reality, there can be no doubt but that the circumstances of this

experiment are very different from those that are met with in the manufactories, where they operate on large quantities of materials, and where the soda that is employed is more proper for the operation, either because it contains more charcoal, or charcoal in a more divided state; and also because there exists a multitude of causes which necessarily alter the results.

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## *Examination of some Iron Ores, and Products of the Smelting-houses.*

*By* M. GUENYVEAU, *Mine Engineer.*

From the JOURNAL DES MINES.

THE works at Creusot are some of the most considerable in France, and perhaps none among those of our neighbours could be compared to them, if they were carried to the full extent of which they are capable. They are also as remarkable for the different kinds of works that are carried on there, as for the goodness and size of the things manufactured.

During my stay at that place, in the beginning of the year 1807, along with my fellow-mine-engineer, M. Bouesnel, a particular attention was paid to the treatment of the iron ore with carbonised fossil coals or coak. This process, which has been introduced from England, might be put in practice in several departments which contain a number of rich mines of iron and coal, if its advantages were better explained and more known than they are at present.

The first and indeed the only trial has been made at Creusot, but the ore that was employed being of a bad quality, as will be hereafter shewn, it is not astonishing that complete success was not obtained, and we cannot con-

conclude any thing against the process itself. Some facts will here be shewn, along with reflections which may serve to explain, on examination, the advantages that may arise from the establishment of iron furnaces for smelting with coals, and to allow a judgment to be formed of the means by which their success may be attained.

The different kinds of ores and fuel employed were collected, as also the produce of the smelting-house, and they were carefully analysed. After the results of these researches have been compared with the facts that were observed, the influence of the component principles upon the phenomena of the smelting-house will be perceived and appreciated. The information collected from M. Chevalet, a partner in the concern, and Messrs. Demeuniere and Pernollet, the managers, and which was given with the utmost readiness, has been of great use, and if the author had not been obliged by unforeseen events to quit the place sooner than was expected, a greater number of facts would have been collected, and the researches rendered still more useful. Nevertheless, incomplete as they are, they are interesting to some persons, especially in respect to the application of practical chemistry to metallurgy.

*Carbonised Coal, or Coak.*

The coal at Creusot is in general of good quality, although it frequently contains iron-pyrites. That which is extracted from the principal bed is caking, and preferred for making coak before that which comes from the *galeries*, a neighbouring mine. This last is drier, and leaves a larger residuum after its combustion than the former.

They

They distinguish two kinds of coak. The first is the best: it is made with large lumps of coal, most commonly extracted from the principal bed, and carbonised in the open air. The second comprehends the coak made in furnaces for that purpose from small lumps of coal. This coak is heavier, and harder to burn than the preceding: it is never employed by itself in the smelting furnace, but is always mixed with the other, in some certain proportion.

I. *Coak made by carbonising the Coal in large Lumps.*

Concentrated nitro-muriatic acid was boiled for an hour upon 20 grammes (308 grains) of powdered coak. Solution of muriate of barytes threw down from the filtered liquor 0.3 gramme of sulphate of barytes, which contained 0.042 gramme of sulphur, and thus exhibited the presence of about three thousandth parts of sulphur in this coak.

Ten grammes of coak reduced to powder and put into a small porcelain cup were burned under a muffle; the combustion resembled that of charcoal, and was accompanied with a bluish flame that could scarcely be perceived, and that only for a short time; the residuum was of a reddish grey, and weighed 0.27 gramme, being about three per cent. of the coak that was used. The presence of lime in it was discovered, as also alumine, silica, and a little oxyd of iron.

TO BE CONCLUDED IN OUR NEXT.

List

*List of Patents for Inventions, &c.*

(Continued from Page 128.)

JAMES BARRON, of Wells-street, in the county of Middlesex, Brass-founder; for improvements on the apparatus used for rollers for window-blinds, maps, and other similar objects. Dated December 5, 1809. Specification to be enrolled within two months.

GEORGE WARE, of the Royal Military Academy Woolwich, Gentleman; for apparatus and machinery for the support and exercise of the human frame, and for the prevention of bodily deformity. Dated December 5, 1809. Specification to be enrolled within two months.

SAMUEL FELTON, of Berwick-street, Soho, in the county of Middlesex, Botanist; for a botanical or medicinal preparation, being a remedy for gravel and stony concretions, which he denominates *Mucilage of Marshmallows*. Dated December 9, 1809. Specification to be enrolled within one month.

JOHN JONES, of Manchester, in the county of Lancaster, Cotton-spinner; for a new sort of instrument or machine for preparing and cutting cotton and linen candle-wicks. Dated December 9, 1809. Specification to be enrolled within two months.

JOHN MANTON, of Dover-street, in the county of Middlesex, Gun-maker; for an improved lock for guns and pistols. Dated December 11, 1809. Specification to be enrolled within two months.

JOHN MURRAY, of Nicholson's-street, Edinburgh, Esquire, and ADAM ANDERSON, of South Bridge-street, Edinburgh, Tin-plate-worker; for a portable stove or furnace, which may be made of cast-iron, forged or plate iron, or of other metals or materials, by which a current of air is heated and discharged, so as to distribute the heat more equally than by stoves such as are in common

common use, and avoid the unpleasant smell which they produce; and which air, if necessary, may be brought from the external atmosphere so as to produce ventilation as well as warmth. A stove of this construction may be usefully applied in warming and ventilating churches, public rooms, halls, stair-cases, and, by means of tubes connected with it, the apartments of houses, and will also be useful to ventilating and heating ships and manufactories, drying different articles of manufacture, ventilating mines, and for other purposes. Dated December 14, 1809. Specification to be enrolled within two months.

JOHN DUFF, of Great Pulteney-street, in the county of Middlesex, Cutler; for an invention, communicated to him by a foreigner, of Snuffers on a new and improved construction. Dated December 14, 1809. Specification to be enrolled within one month.

MARK NOBLE, of the parish of Battersea, in the county of Surrey, Engine-maker; for an improvement on chain and hand pumps, and a new-invented fire-extinguishing-engine and steam-engine. Dated December 14, 1809. Specification to be enrolled within two months.

CHARLES FREDERICK DAVIS, of the parish of Itchcombe, in the county of Gloucester, Clothier; for an improvement in the manufacture of woollen stocking-pieces, by raising and producing on his improved manufacture a nap or pile in resemblance of kersymere and broad cloths; and also an improvement on the manufacture of kersymere and broad cloths, by means of transverse elasticity given to his manufacture, equal in use from its ease in the woollen manufactures. Dated December 20, 1809. Specification to be enrolled within two months.

THE

# REPERTORY

OF

# ARTS, MANUFACTURES,

AND

# AGRICULTURE.

No. XCIV. SECOND SERIES. March 1810.

## *Specification of the Patent granted to* DAVID MEADE RANDOLPH, *late of Warwick-court, but now of Featherstone-buildings, Holborn, in the County of Middlesex, Merchant; for certain Improvements in the Construction of Wheel Carriages of every Description.*

Dated November 6, 1809.

With Plates.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said David Meade Randolph do hereby declare that my said inventions and improvements are particularly described in these presents, and in the several drawings, delineations, scales, and sections thereof, hereunto annexed, with sundry references thereto; reserving in all cases whatsoever shall pertain to my said inventions and improvements, all or any proportionable increase or diminution of the several scales laid down for a more perfect comprehension of my inventions and improvements aforesaid; that is to say: For a carriage with four wheels, intended for a mail or stage coach, or

for the conveyance of persons and luggage, the drawing Fig. 1 (Plate X.) will elucidate, *viz.*

Fig. 1 represents the profile or side view of a carriage, either for the mail or other purpose, having two seats within each, accommodating two sitters face to face; the window *y* sliding back horizontally, and furnished with bolts at the bottom, to secure the door from opening when both are shut.

Fig. 2 describes a seat, in front nearest the horses, and step alternately. *a*, represents the pivot on which a spring acts upon the bolts *d d*, bending from the right line to *e*, and *e*, described by dotted curved lines, pushing these bolts three inches into an upright frame, common to the support of the two moieties of the seat in the middle when the joint at *f* is pulled forward to *g*, whence a clamp projects to fasten the step now folding up, and resting on the side of the door, supporting this division or end of the seat aforesaid. *b b* are pivots, on which the joints *c c c c* freely play; the bolts traverse or pass within long cases or boxes adjusted for their confinement, allowing lateral motion, corresponding with the several levers. The point *f* is a stud upon the upper surface of the seat, under which this machinery performs its purpose, sliding and commanding the whole along the narrow space alternately to and from *g*; the sill of the door serves as a base for stepping that division of this contrivance on when the seat is formed, and also when the same drops down and unfolds the step: the swell in the body of the carriage allowing a sufficient projection outside of the sill aforesaid to guard against contact with any under part of the body; one or two swivels or transum-bolts passing up and down the perpendicular frame before described fastened the opposite

posite sides from drawing back, limit and preserve the seats in their alternate transitions and purposes, as may be understood by observing H I; the door hinged towards the horses; (see Fig. 1,) the width of the step aforesaid being only half that of the seat measured from the front of it, if otherwise too large. In Fig. 1 the point *a* is provided with a hole or joint for attaching a pair of swingle trees by which the hind cattle draw, *b*, the outside seat; these precisely upon the parallel line passing through the centre of the axletrees, and being each and severally precisely of an inclination of three degrees to the plane, descending from the hind to the front wheels upon the intermediate space from *b* to *a*. The inside seats are adjusted so as to preserve the same inclination and parallel pressure aforesaid. *cd* are projections of the body *c* to cover the heads of the outside passengers, and *d* a platform, upon which to rest their feet and those of the guard or other person or persons seated at *e*. The dotted line *c* to *e* exhibiting a curtain of oiled silk or canvass, or other convenient materials, dropped from *c* to defend the passengers aforesaid at *b* from the weather, and at the same time serving as an apron for those on the seat *e*; the space between the two axletrees to be regulated according to the longer or shorter carriage required, always preserving the inclination of three degrees aforesaid. *ff* describe springs, whilst *g g* explain the stays to which they are severally attached; all which being adjusted according to the true inclination of three degrees aforesaid, and the scale belonging to the figure here described *. The front part of the driver's seat, *i*, being directly over, and perpendicularly upon, the front axletree, which,

* The scale is omitted in the plate.

from the wedge form of the platform and body, when the said seat shall contain two or more, the load is to be adjusted so as nearly as may be to impose upon the hind axletree two-thirds of the load in all cases. *h* represents a check spring to aid the others, and to limit the propulsive effect of all sudden shocks. *j* is the pole by which the fore cattle draw, and by which the hind ones hold back in the usual way. *k* is a lock by which to fasten the door also, thus rendering it safe from flying open.

The drawing, Fig. 3, exhibits a carriage, whose perch or perches are shorter (and consequently hind wheels lower, in order to preserve the three degrees descent forward) than that described in the said drawing Fig. 1, as will be found by the scale annexed thereto. This carriage is designed for one seat only within, to accommodate persons in like manner as a post-chaise: the body here particularly described in point of form and appearance being adopted as well for its novelty, that of an acorn, as to prove how susceptible the principle is of assuming any other. The door opens in front and directly behind the driver's seat, who conveniently opens and shuts the same. The steps are fixed upon each side of the floor or platform at the point A, as may be required.

The drawings, Figs. 4 and 5, and the preceding scales shew the form and construction of the platform and carriage part. In Fig. 4 to 5, is the space for the internal length of body, that space beyond each line *a* and *b* aforesaid, behind and forward, serving to shew the space for the luggage box behind from *c* to *a*, under the inside and outside seats and floor for the passengers feet; whilst all that space before

the

the line *b* serves for the boot solely as in Fig. 1; or boot and entry floor as in Fig. 3.

The curved and dotted lines in Fig. 4, marked *c c*, shew how the body may be swelled out as may be required, and the space between the dotted right line *f* and *b*, shews the front seat within the body and step aforesaid. The letter C is at the point from which the wheel-horses draw as before described, corresponding with the point *a*, in drawing Fig. 1; the letter *h* of this same Fig. 4, shews the position of the guard's or other seat, if either such be required.

The drawing Fig. 5, shews the frame or carriage part of such machine, the relative axletrees and wheels, their proportions being formed by the common scale annexed to Figs. 1 and 3 *, the rolling of different surfaces according to different lengths of axletrees and breadth of tracks, and the increasing ratio of the hind wheels and axletrees; the dotted lines *a a* in this Fig. 5, shewing how the perches are formed from the hind axletree to the bolster over the fore one, when preferred to the wings meeting from the same points behind at the circular slides upon which the bolster supporting the platform turns. The futchels embracing the pole in the usual way as by this said drawing Fig. 5. In constructing all waggons and other four-wheel carriages, the drawings Figs. 4 and 5, furnish the form and manner of making the frames or carriage-parts with a platform, floor or base, upon which to build the required bodies; the dotted circular line *c c* shews the manner of swelling out or otherwise widening the bodies, and those two other dotted straight lines in Fig. 8, *a a*, shew how to form three perches when required. Common waggons with or

* The scales are omitted in the plate.

without

without springs to be made with three perches, and double bodied and heavier carriages, or carriages for conveying heaviest loads also; or with one only, and wings as in Fig. 5; in all cases, rolling different tracts and preserving the wedge form; and as far as may be, two-thirds of the several loads upon the hind axletree. All such waggons, coaches, or other four-wheel carriages being drawn in like manner as Fig. 1; to wit: a triangular tractor jointed at each end of the bolster, rising to a line with the horses breast to the point *a*, or a little below it, as in Fig. 1, and swingletrees as aforesaid, precisely perpendicularly over the embrace of the pole by the futchels, thereby providing draft in unison with the left of the front horses by a pole, or an union of a lift and draft as set forth in Fig. 3 at *b*, more particularly necessary when drawn by a pair of horses only, or even by a single horse which is to be done by the use of a pair of shafts instead of a pole. In constructing a particular kind of waggons and carts entirely novel, the carriage part of them, *i. e.* their frames, axletrees, and wheels, differ nothing from my other principles herein explained, as applicable to carriages of two and four wheels: the bodies however rest and traverse longitudinally upon segments of circles, whose semidiameter is eleven feet; which said segments are supported by springs, or otherwise bolted to the several axletrees in the usual way, sufficiently elevated for locking (in the case of waggons), one-eighth round. These segments are of wood plated with metal, or of any proper metal solely, divided into three spaces marked *a a a*, as in the drawing Fig. 6, in which friction rollers are to roll freely backwards and forwards from the two ends thereof, and intermediate hops marked

marked *b b* in the same drawing and figure. But inverted skales or keels to slide on and within the aforesaid spaces *a a a* are also adopted as a mode equally applicable on which to build up the body, and by which means it is precisely on a level, in ascending and descending hills, the front part, (*i. c*) one-third of the body, is contracted as in *b*, drawing Fig. 7, so as to admit of an axletree shorter than the hind one in full ratio, as by the annexed scale in Figs. 6 and 7, rolling different surfaces, as by this said drawing Fig. 7, more particularly appears, leaving the hind axletree of the usual length to be borne by wheels a little dished, as also appears therein to roll outside of and wider tracts than the preceding. The mode of drawing these waggons is by a pole in the usual way and swingle trees for a pair of cattle at the end thereof; from which said end a chain or other line of traction is passed to the nose or front of this said pair of cattle to the end of this said chain or other line of traction; another pair of swingle trees are attached by which another pair of cattle draw, thus providing a mode for four of such cattle to draw from the pole, and which is embraced by futchels extended from the ends of the front axletree within the wheels, whilst another pair of cattle draw and back alternately by means of a double pair of shafts, described in drawing Fig. 9, hung upon the upright segment marked C, in drawing Fig. 6; which said shafts slide up and down and are stayed by a long spring within, sufficiently strong to preserve the point of traction in whatever position it may be placed, by the action of the cattle yielding to the same, whether undulatory or laterally, always finding its level when pulled upon; and the body rolls forward on the convex base,

base, slipping down when backing, and catching under the several jagged points or teeth C, Fig. 6, of the front of this contrivance, as from time to time the operation of holding back shall require. Chains from the end of the pole moreover, in the usual way, are used to govern the same, and so adjusted as to aid in backing by the novel mode of the shafts hereby described. Fig. 9, with a scale thereon affixed, represents a cart with two wheels, formed upon principles similar to those of the last-mentioned waggon described in drawing Figs. 6 and 7; the segment traction iron *d*, being fixed in the centre of the front part of the body, upon which is hung a pair of inner shafts for a single beast to draw and back as aforesaid, and to which other shafts in the common form are also used, leaving them of sufficient width for the body of the cart to roll down between them: in case such cart be drawn by more than one beast, swingle-trees are to be attached to the end of the said outer shafts, by means of a tractor marked A, Fig. 10. For the construction of frames and iron railway waggons, the front wheels of the front carriage must be six inches diameter, the hind ones adjusted according to the length of the body, so as to elevate their centre and form a line of inclination of three degrees, descending from the hindmost wheel of the whole series through their axles and those of the front ones aforesaid. The first carriage, being formed, will furnish the rule and ratio for a whole series: the space between the first and second, and every succeeding tram or iron rail-way waggon is to be fixed, allowing play according to the turnings in the road: fixed however it must be, when every successive carriage must be formed, so as to preserve the three degrees inclination from the aftermost and highest

*Fig. 1.*

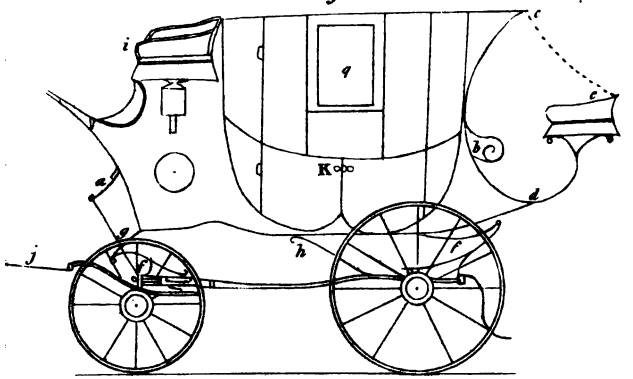



*Fig. 4.*

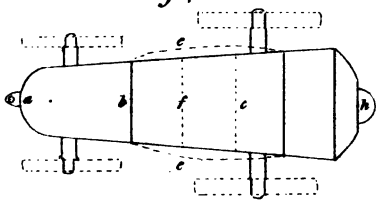



*Fig. 10.*

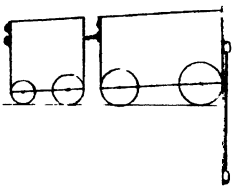
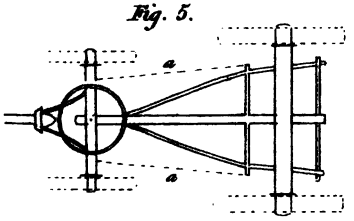


*Fig. 5.*



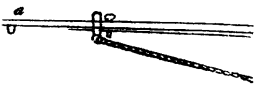
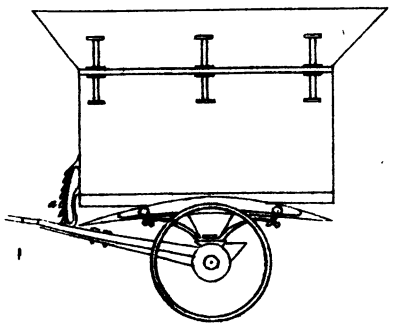
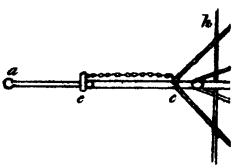




*Fig. 9.*



highest wheels to the lowest in front, which said line passes through every successive axletree, and their said axletrees (increased in diameter) being not less than one-eighth of the heights of their respective wheels, according to a rule required to be observed in the adjusting of all axletrees whatever within the meaning of these presents, whose bearing in their several boxes of their respective wheels and length of naves in the clear, shall in all cases be equal in length to such diameter of axle aforesaid, and whose tread, track, or bearing upon their several roads or plains over which they may pass, shall be equal also to the diameter of axletrees hereby fixed, at no less than one-eighth of the diameter or height of their respective wheels aforesaid; and for the more perfect understanding of the construction and mode of drawing all such trams or waggons, reference is had to the drawing Fig. 10, the annexed scale and a tractor, and swingle tree marked *a*; the rule for adjusting the diameter of wheels, axletrees bearing in the box and tread upon the road being in manner aforesaid; the said improvement in the construction of all carriage-wheels is, among other things, that all shall have an unequal number of spokes; a further improvement in the wheels of all such carriages consists in a construction explained and exemplified in drawings here referred to, Figs. 11, 12, and 13, (Pl. XI.) *viz.* drawing Fig. 11, with its annexed scale of 18 inches, represents this said wheel. A, is the diameter of the box, and consequently the diameter of its axletree, the diameter of the wheel being 3 feet, leaves that of the box and axletree one-eighth of the same, as by scale of 18 inches annexed. The nave is to be of cast-iron as described by the black part marked B B, including the box *per* dotted line, *c c c c c*, shewing sections.

of the sockets formed in the casting, with their wedges formed therein also by the casting, which wedges receive the upper end of the wooden spokes. DDDDDD, represent the same sockets complete at each end of the nave, embracing the spokes aforesaid; E E E E E represent sections of the same spokes, as they are stepped into sockets cut through segments of wooden felloes, till meeting with cast-iron segments of felloes, also curved upwards as in section A, drawing Fig. 12, embracing the wooded segments of felloes aforesaid, with the wedges likewise left in the casting; upon which the foot of the spokes aforesaid are to be forced.

B, Fig. 12, shews a cast-iron section and the form of the mortise through the wooden segment of the felloes aforesaid, whose ends meet at that point, and the wedge in the same, upon which the foot of the spokes are received as aforesaid.

B, Fig. 12, also exhibits the form of a hole or mortise made by bringing together two segments of the cast-iron felloes end to end, as they are to be united by a wedge bolt passing through the same, and also through the middle of wooden segment of the felloes aforesaid, secured by a screw and nut at its end, as will more particularly appear and be understood by C, Fig. 12.

Drawing Fig. 13 exhibits the form and manner of making the axletree, which is of wood or iron, or other metal; if of the latter, that part of the same called the arm or bearing within the box is to be hollow; in either case a screw, with a proper head, is inserted at the end for the purpose of confining the wheel on the same; the length of which bearing in the box, and the diameter being equal to one another, and also the tread or bearing upon the road or plane must be equal to these.

The

The same drawing, Fig. 13, shews a reversed view of the sockets in the cast-iron nave, with the thin wedges aforesaid, into and upon which the upper ends of the wooden spokes aforesaid are to be forced home. These several component parts of the whole being nicely made, the ends of the wooden segments of the felloes meeting between the ends of the cast-iron segments and in the middle thereof, the mortise aforesaid is cut in a diamond form, as by drawing Fig. 12, receiving the foot of the spokes, which, passing through, is forced upon the wedge aforesaid; or this wedge may be of wrought-iron, forced through a suitable space left in the casting of the iron felloes aforesaid. The ends of the cast-iron segments aforesaid meet precisely between the ends of the wooden segments, and a diamond-formed mortise cut through the same allows the wedge-bolt to pass, as in C, Fig. 12. The spokes are to be cut precisely of equal lengths, and fitted to their several sockets. When all things being thus fitted and completed, the same are placed in their due and respective order or situation; every nut fitted to their several and equally well-finished wedge bolts. The combination of the whole is effected by gently screwing the whole up together, as far as from the accuracy of the workmanship it may be practicable, leaving the whole to be confirmed and consolidated by tightening the screws from time to time, according to the workings thereof, till the outer ends of the wedge bolts are drawn even with the tire or cast-iron segments externally. It being understood that wheels of all carriages so constructed are to be lighter, or otherwise, according to the different purposes for which such carriages may be designed.

In constructing gigs, curricles, and all other two-

wheeled carriages, whether upon springs or otherwise, the principle is thus explained, see drawing Fig. 8, (Plate X). A B C is a crank hung upon the firmly-fixed angle B D E, both made of metal at the point B, freely turning thereon upon a pivot D and E, shewing the attachment of angle aforesaid to the frame or shafts, from which a pole is projected for curricles or other two-wheel carriages, with pole only in the usual way. A to F represents stiff traces, made of iron or other metal, or wood, or inner shafts, by which to draw and back. D G are the shafts which support the frame in the usual way. The black line from G to H support the slings either of gig or curricle, or other two-wheel carriage, whether by the pole or shafts; the dotted line I to K shewing the form of the pole fastened to the axle in the usual way. The slings in all cases are furnished with friction rollers, to traverse under the aforesaid black line from G to H. A curricle is furnished with a double pair of shafts, before described for waggons, by which to draw back, but differently hinged, upon a common spindle, turning in and between the holes of two cranks aforesaid, at the points of each, at A. L M is of metal (the same length as B C and A C), upon which the body hangs by springs, as in the said drawing Fig. 8. The front part of the body hangs upon other joints of the cranks at the ends of springs or otherwise, at C. The two points C and M being perfectly level with the plane, thus providing a mode of traction from the joint A, and backing by which to preserve the seat and floor level in going up and down hills.

Drawing Fig. 14, represents a profile view of a road scraper, and earth porter, for the several purposes of scraping loose matter, and in removing the loose

loose earth after having been prepared for the purpose by ploughing or digging, in both and all similar cases, made to collect and carry off the same as here described. At the letter *a*, Fig. 14, a pair of oxen or other cattle are hitched by which the machine is drawn; the lever *b* serves to command and prevent the edge of the scraper from being stopped or obstructed in its progress. In Fig. 15, the same letters *a* and *b*, represent the point of traction and lever aforesaid. That end of the lever, tongue, or pole, projected behind the front axletree, is furnished with a hook as are the two lateral, and diverging lines united at *c*, passing back of the said first axletree as far as the middle or principal lever-tongue before described; and are also provided with hooks, which, when the pole at *a* is lifted up, descend to the bottom of the scraper, to which they are hooked into holes or otherwise as marked *d d d*, so that when the pole aforesaid is pulled back to its proper level, the scraper is lifted up and contains the earth or other matter to be removed; in this operation the united chain at *e*, slides backwards and forwards from *e* to *c*, and when in the act of scraping these chains are pulled upon at *e*, by a pin being perpendicularly inserted in the hole, and form an angle from *c* to each side of the scraper, at the holes marked *f f*, to which they are severally attached.

The letters *g g g*, represent three friction rollers of an inch diameter, to make the edge pass more freely over stubborn unevenesses in the road, when scraping up any liquid or semifluid matter. This said edge, for this purpose is contrived to be fitted on and upon the common edge of the cast-iron scraper, by means of long clamps wrought upon a bar, into nitches, of which the friction rollers are axled, which said clamps

are

are forced upon the common edge aforesaid, and perform their destined purpose the more firmly by the propelling of the whole machine. The said common edge is otherwise sufficiently sharp for loading itself in loosened earth by the plough or digging aforesaid. The upper and back part of the scraper is firmly attached to the hind axletree, upon which as a fulcrum the lever *b* rests, which aids the operation of lifting up the load before described; which said load is preserved lifted by simply resting a common handspike upon the tongue-lever across the union angle, and laying the chains passing near the said points over each end of it; when the load will have been thus simply collected by one person employed at the lever *b*, and another driving the cattle, preserved sufficiently elevated and ready to be rolled away and discharged. The floor of which scraper is of cast iron, leaving channels and holes in the same for the passage of water only, or any other liquid matter. The wheels and axles of this machine are to be in the proportion of all other wheels and axles I have described as my invention, the height of which, I here fix at four feet; the handspike is described by the letter *h*, employed to hold up the load in carrying it off. The sides of the scraper are of wood, raised in like manner as any other sides of waggons and carts, taking greater bulk than on their original construction; mortises being left in the casting, these sides fit in by tenons, and are braced by bars across the top of the said sides, one of which passed over the holes *d*, in Fig. 15, serves to secure the purpose before described, either by upright bolts or short chains attached to the several points *a a a*.

I further declare, that I make use of the power of the lever and wedge in the construction of all artillery carriages,

riages, and any other with four wheels. Their wheels and axles, and the wedge form of their frames or carriage parts, are made according to all my preceding directions in whatsoever particular they apply. But the powers of the lever and the wedge aforesaid, are to be understood as applicable in a similar manner to the intent and uses of the same, in drawing Figs. 14 and 15, by which to lift alternately the first and hind wheels over extraordinary obstacles, or any uncommon obstructions over which it is desired to pass them. And as these particular wheels also are necessarily of equal height, both the tongue lever marked *a*, and that behind marked *b*, may be so contrived as to serve for the alternate purposes; also, of a pole by which to draw the same carriage backwards; the guns in either case being bedded in the usual way; whilst the inner, and three-forked ends of the said levers are furnished with bars across the same to press up the gun bed or piece aforesaid, two upright iron bars on either side of the bed of the gun are firmly mortised into and fastened to the axletrees, passing through correspondent mortises in the bed-frame aforesaid, which, when keyed down, confine the same in its common position; but which, when unkeyed, allow the bed to rise up at the command of the lever at each alternate end of the carriage, *ad libitum;* and when drawn back as aforesaid, the swingle-trees heretofore fixed on the pole, as well for the wheel or leading horses, are removed to the after lever, the former one serving to guide the carriage by hand; the said lever serving the purpose of a tiller, whilst the former front wheels produce the same effect as the rudder of a ship.

In witness whereof, &c.

*Specification*

*Specification of the Patent granted to* JOHN DUMBELL, *of Mersey Mills, in the Parish of Warrington and County Palatine of Lancaster, Miller; for a Method or Methods of Flax-spinning, and of preparing or making a Species of Twist, Thread, Furniture, Cloth, Trills, or Attiré, which he calls* Telary Teguments, *from Silk, Wool, Cotton, Flax, Hemp, or Tow, as well as from a very great Variety of other Articles, in a combined or uncombined State; and for a Method or Methods of refabricating or renovating the same, and of producing or reproducing from Tatters in general a new Body.*

Dated August 25, 1808.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Dumbell do hereby declare that the nature of my said invention, and the manner in which the same is to be performed, are particularly described and ascertained as follows; that is to say: As to flax-spinning, according to my said method or methods, instead of preserving the vegetable fibres or staple thereof as long as possible, and spinning the same by means of such wheels, machines, or instruments, as are usually applied to that purpose. I do by means of shears or scissars, or a knife or knives, or of any other suitable cutting tool or tools, either managed by hand, or fixed, or set in and used along with any frame or engine, heretofore commonly used for similar purposes (by manual labour or any other first mover) cut the said vegetable fibres or staple into such lengths as shall render the same fit to be manufactured by the machinery now used for spinning cotton, and that I do find the common agricultural machine or instrument, called the chaff-

cutter,

cutter, to be a very fit instrument for cutting the said fibres or staple (excepting that the cutting or section would not be neat but shagged) at the portions or parts of the flax, cut at or about the termination of each stroke of the cutting knife; that is to say: Near the bottom and particularly near the angles of the body or containing box, if a remedy were not to be applied for this inconvenience; and the remedies which I apply either jointly or severally as may be preferred or found most advantageous, according to circumstances, in the use of the said machine or instrument, do consist in supporting the flax by a thin stratum or layer of straw, or rushes, or reeds, or other similar substance, which in consequence becomes cut along with the flax. Or otherwise I do remedy the said inconvenience by making the delivering parts of the body or containing box, not of an angular but circular or curved form. Or otherwise I make the said delivering parts with one angle only, opening towards or facing the stroke or course of action of the cutter; and into the said angle, if cutting downwards, I put a support of straw, rushes, reeds, or other similar substance as before. Or otherwise, I do construct my chaff-cutting machine, so that the cutting stroke shall be made not downwards but upwards. Or lastly, I do make my cutter of extraordinary strength and thickness, in order that the edge thereof may not spring or give way; and I cause the same to act by moving in close and very fair contact with a face of iron or steel, or other fit material; and I do protrude the flax intended to be cut through one or more apertures in the said face; and further, that in order more effectually to open, divide, and separate the said vegetable fibres or staple, and to render the same much finer and

more soft and flexible than can with facility be effected in the usual methods of working the long uncut fibres or staple, I do, as occasion may require, operate upon and work the said fibres or staple (after having duly cut the same as aforesaid), by pounding, beating, crushing, bruising, stamping, or rolling the same; and also by steeping, macerating, digesting, boiling, spreading, opening, exposing, or bleaching the same. And after having so prepared the said flax, I do treat the same in the same manner as cotton is usually treated in the manufacturing thereof; and I do spin the said flax in the cotton-spinning engines in the same manner as cotton is spun. And I do further declare, that I do make use of and apply, wholly or partially as occasion may require, the methods of operation hereinbefore described, with regard to flax, to silk, wool, cotton, hemp, tow, and such other bodies as afford a fibre or staple, fit to be spun and manufactured into piece goods. And, that I do according to the nature of the produce or article intended for the market, mix, unite, or combine and work the said materials together in various proportions, and that the operation of spinning flax, prepared as hereinbefore described, is much facilitated by an admixture of cotton, or of silk, or of wool, and also, that the fibres or staple of flax are rendered fitter for spinning by subjecting the carded material to strong pressure, with or without the application of heat at the same time, by means of presses, cylinders, or other instruments. And moreover, that I do re-fabricate or renovate the said produce or articles, and do produce or re-produce a new body or material from any other articles composed of fibres, and worn, cut, or divided into tatters or fragments; and, that in such re-fabrication, renovation,

renovation, production, or re-production I do cut the said produce or articles into portions, or shreds, or stripes; and do again cut the said portions, shreds, or stripes, if need be, into short pieces; and that I do reduce the same to a loose staple fit for spinning, by one or more of the mechanical operations hereinbefore described and set forth, or by such well-known methods of mechanical treatment as may be best suited to each and every of the materials herein before mentioned.

In witness whereof, &c.

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*Specification of the Patent granted to* JAMES BARRON, *of Wells-street, in the County of Middlesex, Brass-founder; for Improvements in the Apparatus used for Rollers for Window-blinds, Maps, and other similar Objects.*

Dated December 5, 1809.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said James Barron do hereby declare that my said invention is fully described and ascertained by the drawings in the margin of these presents, and the following description thereof; that is to say:

Fig. 1 (Plate XII.) is a front view of a window blind or roller map when fixed in its place, with my improved apparatus. The brackets at A and B are fastened to the lath, and suspend the roller by the pivots C D, Figs. 2 and 3, or conical sockets E and F, Fig. 4. I prefer conical sockets, as producing less friction; but cylindrical sockets and cylindrical pivots may be used when desired. The bracket B is a spring fastened on

the top of the lath, the use of which is to keep the blind to any part of the window where drawn to: it is regulated or made to act with more or less force by the wedge G, Figs. 5 and 6, which causes it to raise the roller, and to press the pulley more or less against an iron or metal plate, fixed to the under side of the lath at H, Fig. 6. The wedge G moves in a slanting bed, sunk in the top of the lath under the spring, and crosswise to it. The wedge is moved backwards and forwards by the screw K, let through the edge of the lath, which causes the wedge to rise above the surface of the lath, and bear up the spring with it. Fig. 7 is a longitudinal section of wedge and screw. The blind being drawn downwards, the pressure of the pully against H, produced by the spring bracket, prevents the weight of the blind from running it down: and in like manner when the blind is to be rolled up, by pulling the line P, the spring being then drawn down, the pressure of the pulley will be removed, and the blind rolls up freely to any height desired; for by ceasing to pull the line P the spring immediately presses the pulley against the curved plate H, which stops all farther motion. The line P winds round a small spindle between two circular plates, in the usual manner. The bracket A may be fixed in the under side of the lath, and contrived to slide outwards, in order to withdraw the pivot, and allow the roller to be taken down at pleasure for cleaning or preserving the blinds. The bracket slides between a metal plate and the lath. It is retained to the plate at the outer end by a staple at *a*, Fig. 8; and the end of the bracket has a button, which slides through a slit in the plate, see *a*, Fig. 9, and keeps that end of the bracket steady. The slit has a notch in the side at the inner extremity into which the

Fig. 1.

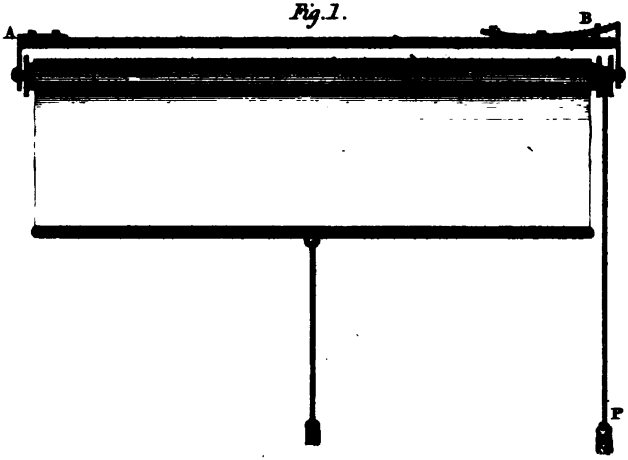


Fig 5.

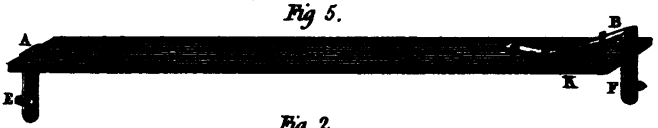


Fig. 2.

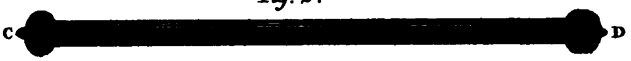


Fig. 3.

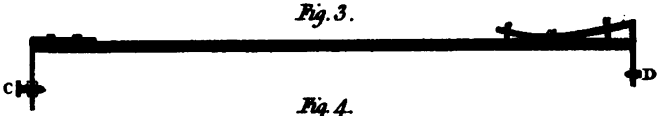


Fig. 4.

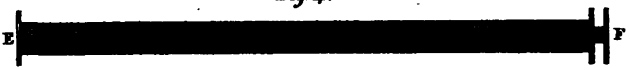


Fig. 6.

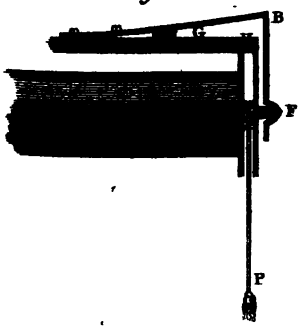


Fig. 7.

Fig. 8.

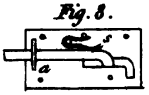


Fig. 9.

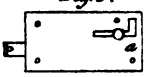


Fig. 10.

the button is forced by the spring *s*, which moves the end of the bracket sideways when it is drawn in, and this keeps the pivot of the roller tight. But when you want to take the blind down, push the button out of the notch, and (being fastened to the bracket) as you draw the button along the slit the bracket will slide out and release the pivot. Fig. 8 is a view of the upper side of the plate and bracket A. Fig. 9 is a view of the under side; both shewing the bracket half drawn out. And Fig. 10 is a section of the same, as connected with the lath and roller. For adjusting the pivots with greater nicety, the pivot D or C may be made to screw through the bracket, by which means the inaccuracy of the workman who mounts the roller can be corrected.

In witness whereof, &c.

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*Specification of the Patent granted to* GEORGE POCOCK, *of the City of Bristol, Schoolmaster; for his Invention of Geographical Slates for the Construction of Maps.*

Dated June 28, 1808.

With an Engraving.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said George Pocock do hereby declare that my said invention of geographical slates for the construction of maps is described in manner following; that is to say: My invention consists in drawing and conducting the lines of latitude and longitude, or other material lines or projections, according to the sort of maps required, on the substance commonly known by the appellation

lation of slates; which lines shall serve as guides to learners of geography to sketch the relative situations of the different parts and kingdoms of the world. In the margin of these presents (see Fig. 1, Plate XIII.) is given a drawing of the lines that are proper to be drawn and indented on a slate for the scholar to prepare a map of the eastern and western hemispheres, though more or less lines may be introduced on slates of various sizes. Slates for forming maps of the several quarters of the world, or any parts of it, are to be prepared with appropriate lines, according to the kind of map required. Any convenient mode may be adopted of drawing and conducting the lines on the slates; but the method that appeared to me the best or readiest, is to take a thin plate of metal, or other suitable substance, upon which I mark the longitudinal lines of the globe, and cut out the space desired between the two middle ones, leaving the space on each side solid. I then cut out spaces between the next two on each side, and so proceed, leaving an alternate space solid and open till I have finished one hemisphere. This plate will then serve as a ruler or guide, by which the longitudinal lines may be drawn and indented on the slate by a sharp-pointed tool, or other proper instrument. The latitudinal lines may be made in the same way by another plate cut out in a similar manner.

In witness whereof, &c.

*Specification*

*Specification of the Patent granted to* JOHN JONES, *of Birmingham, in the County of Warwick, Gun Lock and Barrel Maker, for certain Improvements in the manufacturing Skelps for Fire Arms.*

Dated November 5, 1809.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Jones do hereby declare, that my said invention is described in manner following; that is to say: The principle of my invention consists in the manufacturing iron skelps, (for the making of barrels for military or such other fire-arms as are subject to strong proofs of gunpowder,) by rolling or otherwise making plates of iron in a taper-like form, sufficiently large to be divided into several of them, and so that, when cut into skelps, the grain or fibres of the iron may be drawn transversely in every skelp, instead of longitudinally, as by the forge hammer, which is the present mode of manufacturing them. Take a slab, or piece of iron, in a wedge-like or other convenient form, the length of which must be in proportion to the length of the skelps required; and the weight, according to the number of skelps desired to be cut out of each plate. Heat the slab, or piece of iron, to the usual degree of heat observed in rolling plates of iron; then, with the common apparatus in general use for rolling plate iron, form it into a plate thicker at one edge and side than the other, which thickness must be according to the sort of skelps wanted. The thick edge and taper-like form will be best produced by reducing the circumference of one end of one roller, or one end of each roller, a few inches in the

the longitudinal direction of it or them, according to the sort of skelps wanted; or nearly the same effect may be produced with a pair of rollers, of equal diameter throughout, by giving one end of the upper roller more liberty than the other. The plate of iron is then to be cut or divided into skelps, or strips for skelps, longitudinally from the thin to the thick edge, or from the thick to the thin edge. But to prevent waste in cutting or dividing the plates into skelps of the form wanted, they may be cut, or divided, into strips about the width of the muzzle, or fore end, of the skelp; in which case the plate must be formed somewhat thicker on the thick side and edge, in order to admit of the strips being a little widened by a forge or tilt hammer, or by any other means. Where it may not be convenient to roll the plate wide enough to form the skelps in one length, it may be done in two or more parts, and joined in the welding of the barrel, or in the skelp form. The barrels manufactured from these skelps I find to be more clear, and more free from grays or flaws, which I conceive arises from the great pressure and quickness of the heavy rollers upon the iron, in so hot a state, forcing the pure metallic particles to cohere more closely than can be effected by the partial strokes of the tilt-hammer upon the iron, less hot: and by the grain or fibres being, by this process, laid round, parallel with the edge of the breech, they partake, in some degree, of the nature of what are termed twisted barrels, gain a considerable addition of strength, and consequently stand proof with less risque of bursting.

In witness whereof, &c.

*Specification*

*Specification of the Patent granted to* JOHN MANTON, *of Dover-street, in the Parish of Saint George Hanover-square, and County of Middlesex, Gun-maker; for an improved Lock for Guns and Pistols.*

Dated December 11, 1809.

With Engravings.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Manton do hereby declare that my said invention is described in the plan or drawings in the margin of these presents, and the description thereof hereunder written; that is to say:

The drawing Fig. 2 (Plate XIII.) shews the outside of the lock when at half cock; Fig. 3 the outside when struck down; and Fig. 4 the plan of the inside. Let A represent the outside of the pan. B the hammer. C the cock. D the pin or screw, which confines the hammer and hammer spring, and on which the hammer acts. E the inside end of the pan, which comes opposite the touch-hole. The hammer B acting downwards opens that side of the pan nearest to the cock C to admit the sparks to the prime. The manner of its opening is described in the drawing Fig. 3. The hammer returning to its jointing, fills up the opening in the pan. The hammer is furnished with a strong steel pan, fastened by a stud in the back, and a small screw through the hammer. At the end of the hammer face nearest the pan, is a small groove or notch, sunk in the hammer, to carry off any wet that may come down upon it. The hammer is fixed to the plate by the same screw D that fastens the hammer-spring on the inside. The hole in the

shank of the hammer being screwed, it turns on the hammer-spring pin D, which comes through the plate about three-eighths of an inch. There is a projection on the inside of the hammer-spring one-fourth of an inch long, which comes through a square hole in the plate into a hole in the shank of the hammer, and forces it to return to its jointing with the pan when the lock is brought to half cock. The cock C is flat on the inside, and is barely one-eighth of an inch thick. It passes between the plate and the hammer when it comes down. The jaws project outwards to answer the hammer. A bulge is left on the breast of the cock to render the fitting of the squares of the tumbler more strong and perfect. When the lock is struck down, the flint comes in contact with the hammer-face near the end, and forces it down sufficiently to admit the sparks into the pan. The pan is three-fourths or seven-eighths of an inch long, from the outside of the plate.

The drawing, Fig. 4, shews the inside of the lock so very plain and clear that it cannot be misunderstood by any lock-maker. The inside of the pan E is round, and the same size from end to end. About one-third is cut out to receive part of the hammer, as described in the drawing Fig. 2. The main-spring has a stud like others. The end of the stud side is beveled to fit under the end of the nib, by which it is prevented from rising. The crane of the tumbler has a roller in the end, on which the main-spring acts. The bridle has a strong leg on the inside, with a round stud, which fits into the plate near the sear nose, to prevent it from twisting when the tumbler comes in contact with the eye to stop the cock. The sear acts on the tumbler in the usual way, but the shank is nearly vertical instead of horizontal,

Fig. 2.

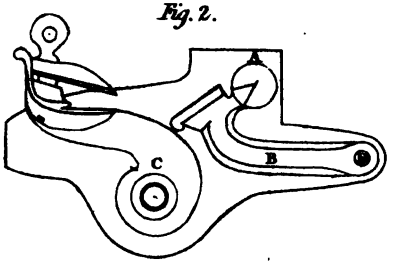



Fig. 3.

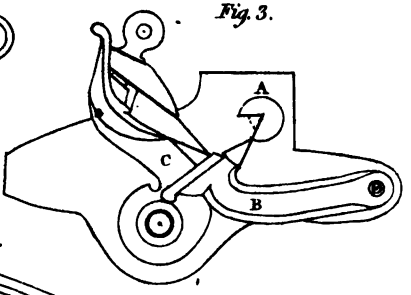



Fig. 4.

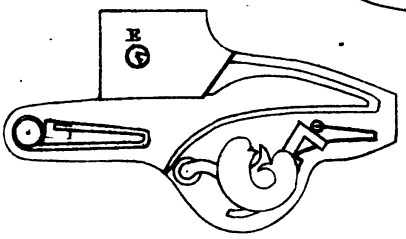
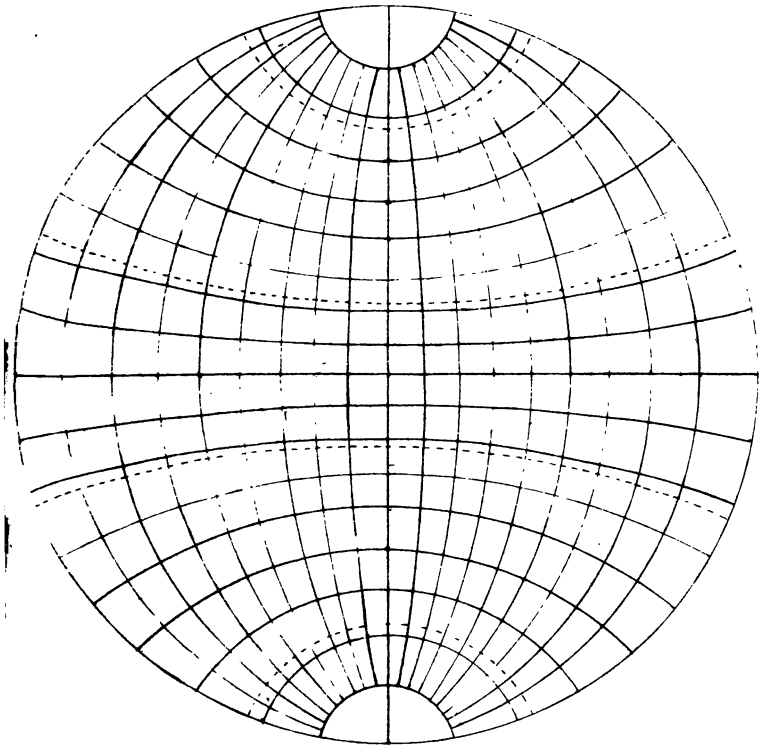



Fig. 1.



tal, as they are in general. The sear spring acts on a shoulder left on the outside of the sear for that purpose, and forces the sear nose to the tumbler. The pan of this lock is primed from the touch-hole, by the compression of the air in loading.

The following are the principal advantages derived from this improved lock. First; the pan being solid with the plate at top, protects the prime from wet. Secondly, the hammer opening downwards, and the flint acting in a direct line with the pan, the sparks communicate quicker to the prime. Thirdly; the hammer returns to its jointing with the pan when the lock is brought to half-cock without any additional trouble to the user. Fourthly; the lowness and compactness of the lock altogether render it much less difficult to protect from wet, and much less liable to accidents, by catching in cover shooting, than locks of the present construction.

In witness whereof, &c.

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## *Method of preparing from Bean Stalks, a Substitute for Hemp. By the Rev.* JAMES HALL, *of Chesnut Walk, Walthamstow.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

*The Silver Medal was voted to Mr.* HALL *for this Communication.*

THOUGH it has not been attended to, nor, so far as I know, has ever been mentioned by any one, yet it is certain that, according to its size, every bean plant contains from 20 to 35 filaments, or fibres, running up on

the outside, under a thin membrane, from the root to the very top all around, the one at each of the four corners being *rather thicker*, and stronger than the rest. It is also certain that, next to Chinese, or sea-grass, in other words, the material with which hooks are sometimes fixed to the end of fishing lines, the filaments, or hempen particles of the bean plant are among the strongest yet discovered. These with a little beating, rubbing and shaking, are easily separated from the strawy part, when the plant has been steeped 10 or 12 days in water; or is damp, and in a state approaching to fermentation, or what is commonly called rotting. Washing and pulling it through hackles, or iron combs, first coarse, and then finer, is necessary to the dressing of bean-hemp; and so far as I have yet discovered, the easiest way of separating the filaments from the thin membrane that surrounds them.

From carefully observing the medium number of bean-plants in a square yard, in a variety of fields on both sides the Tweed, as well as in Ireland, and multiplying them by 4840, the number of square yards in an acre, and then weighing the hemp, or filaments of a certain number of these stalks, I find that there are at a medium, about 2 cwt. of hemp, or these filaments, in every acre, admirably calculated for being converted into a thousand articles, where strength and durability is of importance, as well as, with a little preparation, into paper of all kinds; even that of the most delicate texture.

Now since there are, at least 200,000 acres of ticks, horse and other beans planted in Great Britain and Ireland, and since where there is not machinery for the purpose, the poor, both young and old, females as well

as

as males, belonging to each of the 9700 parishes in England, &c. where beans are raised, might (hemp having risen of late from 60 to 120 pounds per ton) be advantageously employed in peeling, or otherwise separating these filaments from the strawy part of the plant, after the beans have been threshed out; I leave it to the feelings of the Society for the Encouragement of Arts, &c. to judge of the importance of the idea held out here, not only to the poor, but to the landholders, and the community at large.

It is nearly twelve months since, by analysing its component parts, I discovered hemp in the bean plant. I would have written to the Society then, on the subject, and sent a specimen, but that I was trying experiments with other plants, as I am during my leisure hours doing at present; and I wished to ascertain in what degree this species of hemp is liable to injury from different situations, and the changes of the atmosphere. With a view to this, I exposed one parcel nearly 12 months, to all the varieties of the air within doors, and kept another nearly as long *constantly* under water, and find them not in the least injured. The chief difference I perceive is, that the one kept constantly under water, namely the *whitest* of the specimens sent to the Society, has assumed a rich silky gloss, and a much more agreeable colour than it had before.

But though this is the case with bean-hemp *after* it is cleaned and dressed, and which, though stiff and hard when dry, is pliable and easily managed when rather damp or wet, it seems otherwise with it *previous* to its being separated from the straw. If bean-straw be kept for years under water, or quite dry, it produces I find hemp as good and fresh as at first. But, if the straw be sometimes

sometimes wet, and sometimes dry, the filaments or fibres are apt to be injured. The specimens of bean-hemp accompanying this letter, in the form of oakum for caulking ships, having been long exposed to the varieties of the weather, previous to being separated from the straw, is a proof of its being considerably injured. If the straw of the bean was scattered thin on the ground, and exposed to the weather for two or three months, I have uniformly found that the hemp, or fibres, are loosened, and easily separated from the strawy part, without any other process than *merely* beating, rubbing and shaking them, and perhaps this is the easiest way of obtaining bean-hemp; but then, from being thus exposed, and the fermentation that takes place in the strawy part, which is of a spongy nature, communicating itself to the fibres, or hemp, I find that these are generally less or more injured, though not so much so, in my opinion, as to prevent them from being excellent materials for making paper.

I have also found, and the importance of the idea will, I hope, be an excuse for mentioning it here, that, though the water in which bean-straw has been put to steep, in a few days generally acquires a black colour, a blue scum and a peculiar taste, yet cattle drink it greedily, and seemed fattened by it. But my experiments have hitherto been on too limited a scale to be able, in a satisfactory manner, to ascertain this last circumstance. When the water in which bean-straw has been put to steep, becomes fœtid, which I find it is *scarcely* more apt to become than common stagnant water, on being stirred by driving horses or cattle through it, by a stick, or in any other way set in motion, (as is the case with all putrid water, even the ocean itself)

itself), the fœtid particles fly off, and the effluvia dies away.

When straw is to be steeped for bean-hemp, the beans are to be threshed in a mill: the beans should be put to the mill, not at *right angles*, but on a *parallel*, or nearly so, with the rollers; else the straw, particularly if the beans are very dry, is apt to be much cut. If the straw is *not* to be steeped, on putting the beans to be threshed at right angles, or nearly so, with the rollers of the mill, a certain portion of the fibres, or hemp, may easily be got from the straw, these being in general not so much cut as the straw; but often found torn off and hanging about it like fine sewing threads. The hemp thus taken off, though its lying under for months would do it no harm, requires only to be steeped a few minutes, drawn through a hackle and washed, previous to its being laid up for use. If the hemp, or fibres, collected in this way (which is a fine light business for children, and such as are not able for hard work, and which requires no ingenuity) are intended only for making paper, they require neither steeping nor hacklings, but only to be put up into parcels, and kept dry till sent off to the manufacturer.

The straw of beans contains a saccharine juice, and is highly nutritive, perhaps more so than any other; and like clover, the prunings of the vine, the loppings of the fig-tree, &c. produces a *rich* infusion, and uncommonly fine table-beer, as well as an *excellent* spirit by distillation. It is the hemp or fibres that prevents cattle from eating it. These, like hairs in human food, make cattle dislike it. The collecting of it, therefore, should never be neglected, nor the boys and girls in workhouses and other places be permitted to be idle, while business of this

this kind would evidently tend both to their own and their employers' advantage.

It is a fact, that about the generality of mills for beating and dressing hemp and flax, a large proportion, in some inland places both of Great Britain and Ireland, amounting to nearly one-half of what is carried thither, is either left there to rot, under the name of refuse, or thrown away as of no use, because too rough and short for being spun and converted into cloth. Now, from the experiments I have tried, and caused to be tried, I have uniformly found, that, though too rough and short for being converted into cloth, even of the coarsest kind, the refuse of hemp and flax, on being beat and shaken, so as to separate the strawy from the stringy particles, which can be done in a few minutes by a mill or hand-labour, as is most convenient, becomes thereby as soft and pliable, and as useful for making paper, as the longest, and what is reckoned the most valuable part of the plant, after it has been converted into cloth, and worn for years.

In its natural state, it is true, the refuse of hemp and flax is generally of a brown and somewhat dark colour. But what of that? By the application of muriatic acid, oil of vitriol, or other cheap ingredient, well known to the chemists, as well as to every bleacher, such refuse, without being *in the least* injured for making paper, can in a few hours, if necessary, be made as white as the finest cambric.

There are, at a medium, published in London, every morning 16,000 newspapers, and every evening about 14,000. Of those published every other day there are about 10,000. The Sunday's newspapers amount to about 25,000, and there are *nearly* 20,000 other weekly papers,

papers, making in all the enormous sum of 245,000 *per* week. At a medium twenty newspapers are equal to one pound; hence the whole amount to about 3 tons *per* week, or 260 tons *per annum*. But though this, perhaps, is not one-half of the paper expended in London on periodical publications, and what may be called fugacious literature, and not one-fourth part of what is otherwise consumed in printing-houses in the country at large, yet there are materials enough in the refuse of the hemp and flax raised in Britain and Ireland for all this, and much more.

Nor is this all; for as the bine or straw of hops, a circumstance well known to the Society, contains an excellent hemp for making many articles, so also will it prove a most excellent material for making all kinds of paper. And it is a fact, that were even the one-half of the bine of hops raised in the counties of Kent, Sussex, and Worcester, instead of being thrown away, or burnt, after the hops are picked, as is commonly done, steeped for ten or twelve days in water, and beat in the same way as is done with hemp and flax, independent of what might be got from bean-hemp, and a variety of articles well known to the Society, there would be found annually materials enough for three times the quantity of paper used in the British dominions.

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*Certificates of the Truth of the foregoing Statement.*

*Streatham, Surrey, Jan. 9,* 1809.

We, the undersigned, do hereby certify, that the specimens of hemp inclosed and sealed up by us, addressed to Dr. Taylor, Secretary to the Society for the Encouragement of Arts, Manufactures, and Commerce,

Adelphi, Strand, are the produce of common bean-straw:—That we never saw nor heard of bean-hemp till lately: when the Rev. James Hall, who resides here at present, was trying experiments respecting it at Mr. Adams's farm, Mount Nod, and other parts of this parish:—That, in the present obstructed state of commerce with the Continent, it appears to us the discovery of bean-hemp may be extremely useful to the manufacture of canvas, ropes, paper, &c.;—And that, as it affords a new and important prospect of employment for the poor, we think Mr. Hall, the discoverer, is deserving of the approbation of the public. We shall only add, that as the Society for the Encouragement of Arts, Manufactures, and Commerce, have contributed so often in a high degree to the exertion of genius, the improvement of the arts, and the public good, we have no doubt but they will not only take the proper steps to prosecute the discovery and encourage the manufacture of bean-hemp, but also, by some mark of their favour, show their approbation of Mr. Hall's merit in the discovery he has made, as well as of his high public spirit and liberality in communicating the discovery to the public without reserve.

WILLIAM ADAMS, Mount Nod.
EDWARD BULLOCK, Curate.
WM. GARDNER, Surgeon.

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*Streatham, Surrey, Jan.* 9, 1809.

These are to certify to the Secretary of the Society for the Encouragement of Arts, &c. London, and all whom it may concern, that having seen (at first to our astonishment) the Rev. James Hall, who has resided here for some time past, procuring hemp from common bean-

bean-straw, steeped some days in water, we steeped some also, and easily got hemp from it; there being no mystery in the matter more than *merely* steeping the straw, peeling off the hemp, and then washing and cleaning it, by pulling it through a hackle or comb.

These are also to certify, that having tried bean-hemp, and found it to take both wax and resin, we have sewed with it, and find the fibres of which it consists in general so strong, that the leather never failed to give way sooner than the seam. We have only to add, that as hemp has of late become uncommonly dear, while much of it is bad, we anxiously wish the prosecution of the discovery, and the appearance of bean-hemp in the market; and shall, so soon as we hear of its being spun and on sale, be among the first to purchase and use it.

JOHN HOUNE, Shoemaker.
THOMAS ALFORD, Shoemaker.

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*Letter from Mr. Hume of Long Acre, to the Rev. James Hall.*

Sir,

I inclose a specimen of the bean filaments or thread which have been submitted to the bleaching process. The texture and strength seem not in the least to have been impaired, but retain the primitive tenacity; and I am persuaded this substance will prove an excellent substitute for hemp and flax, for the manufacture of various kinds of paper, cordage, and other materials. I did not find more difficulty in accomplishing the bleaching of this than in other vegetables which I have occasionally tried, and I believe this article is susceptible of a still greater degree of whiteness. I am yours, &c.

*Long Acre, Feb. 24,* 1807. JOS. HUME.

*Letter from Mr. H. Davy to the Rev. James Hall.*

Sir,

I shall inclose in this paper a small quantity of the bean fibre, rendered as white as possible by chemical means.

It seems to bear bleaching very well, and as to chemical properties, differs very little from hemp.

The question, whether it is likely to be of useful application, is a *mechanical* one, and must be solved by experiments on its comparative strength.

I am yours, &c.

H. DAVY.

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*On the Culture and superior colouring Qualities of Madder raised from Seeds procured from Smyrna. By Mr.* WILLIAM SALISBURY, *of the Botanic Gardens at Sloane-street and Brompton.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

I HEREWITH send two samples of extract of Madder, one of which marked A is produced from the root of the Smyrna kind, a plant which I have not heard of being before introduced into this kingdom, the seeds of which I received from Dr. Taylor, and which he informed me had been procured at the request of the Society of Arts, &c. from Smyrna, by J. Spencer Smith, Esq. I sowed the seeds in my Botanic Garden, at Cadogan-place, in April 1808, in a soil rather inclining to clay; and I have the satisfaction to find, from this experiment, that there is every appearance of its being cultivated with considerable success; for if I might venture to state a calculation

calculation made of the crop from the small quantity grown, the produce would be upwards of fifteen hundred weight of the fresh root per acre.

The above estimate is made on the supposition that the seeds were sown in drills at one foot distant from each other, which appears to me to be the best mode for its cultivation. I am thus particular, as I conceive I shall be doing my country a service, if it will induce any person to attempt the culture of this madder on a larger scale. I beg leave to observe, that the first attention which I paid to this valuable vegetable, after I had raised it from the seed, was to ascertain satisfactorily whether the superior quality of its colouring matter depended on the plant itself, or if it was merely owing to climate, or other local circumstances, which often occasion a great difference in the quality and value of many other productions of a similar nature; to prove this I had extracts made in the same manner with the prepared Dutch madder of our shops, which did not bear any comparison in point of colour with that of mine; but fearing that the Dutch madder might be damaged by the mixture of some extraneous substance, I made a similar extract from the fresh roots of the common rubia tinctorum, which had for some years past been growing in my garden at Brompton, and the extract marked B is the result, and is much inferior in colour to that from the Smyrna seed; though the extracts were both obtained in the same way, viz. by boiling the roots and making a precipitate from them by alum and vegetable alcali.

I flatter myself I have here been instrumental in the introduction of a plant, producing a very valuable dye, and hope we may not be long under the necessity of depending upon a foreign market. If any gentleman would

would wish to make experiments relative to its growth, or if any seeds of a similar nature should come into the Society's possession, I shall be happy to make experiments with them, having appropriated a piece of ground in my new botanic garden solely for such purposes. I must confess, that I have great pleasure in the above communication, as it will prove that benefits occur from botanical institutions, and that the opinion formed by some persons, that the study of botany is a dry nomenclature, is founded in error; for certainly much good will arise from botanical investigations to Medicine, the Arts, and Manufactures.

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In answer to further enquiries respecting the madder procured from the Smyrna seed, I beg leave to observe, that with regard to the management of the seed, I found it to succeed extremely well in drills in the open ground. I have also tried some in a hot-bed, which also succeeded perfectly well, but the old seed, some of which I had from you this spring, will not grow. I consider it to be a variety of the common rubia tinctorum, but of a more robust growth, and superior in colouring matter. These plants thrive exceedingly in my new botanic garden in Sloane-street; and I flatter myself that I have been instrumental in introducing an article which gives to cotton the most beautiful and permanent red colour in existence.

Many former attempts to cultivate madder in England have failed, I understand, on account of the calico-printers formerly requiring it in a powdery state; but since the establishment in this kingdom of the Adrianople or Turkey red dye upon cotton, some thousand tons in weight of

of madder roots from the Levant are annually used in Great Britain for dyeing that colour, and for which use this kind of madder in the fresh root will be found superior.

I am informed that by the application of the Society of Arts, &c. to Government, madder roots grown in England are exempted from tithes.

I have every reason to believe, that for use in painting much finer colours than the present may be obtained from the roots of this plant by spirituous or acetous extracts; but I forbear at present further experiments, in order to increase as much as possible my remaining stock of plants; and this appears necessary, as I find the seed I had left will not vegetate this spring, and I apprehend that such seed as may now remain in the Society's possession will be useless.

I shall therefore proceed to increase my present stock of the plants from offsets and cuttings of the roots. If the above account is found deserving of the Society's attention, it is much at their service; and they shall be welcome to some of the roots when I have further propagated them. They blossomed abundantly, but did not produce seed, a circumstance which I observed also in the common kind growing near it. I have therefore endeavoured to increase it by other means, which may be done to any extent, but being now particularly engaged, the means I employ must be a subject of future communication.

*Experiments*

## *Experiments and Observations on the Prussic and Prussous Acids.*

*By Mr.* R. PORRETT, *Jun. of the Tower.*

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

*The Silver Medal was voted to Mr.* PORRETT *for this Communication.*

I TAKE the liberty of offering to the Society of Arts, Manufactures, and Commerce, a Memoir on the Prussic Acid, detailing some experiments, by which I have attempted to prove that oxygen is one of its principles, and giving an account of a new acid which I have been fortunate enough to discover.

Considerable differences of opinion exists among the most celebrated chemists respecting the composition of the prussic acid; some agreeing with Fourcroy and Vauquelin, that oxygen is one of its component parts, and others with Berthollet and Proust, who dispute its presence. M. Proust, in his history of the Prussiates, asserts, "That there is no fact that indicates oxygen to make a part of this acid, and that from the well-known affinities of its three elements, added to the circumstances under which it is formed, it can scarcely be thought that it does." This difference of opinion implies a want of some decisive experiments, which may set the question for ever at rest; and those which I am going to relate I am induced to think are of that description.

Some time back I proposed to myself the discovery of a method of preparing a triple prussiate of potash, in a pure state, which should be free from the objections to which

which the processes in general use are subject. In reflecting on the means most likely to attain this end, it occurred to me, that I should succeed if I decomposed prussiate of iron by double elective attraction rather than by single, employing, instead of a pure potash, that alkali, in combination with a substance uniting the properties of solubility when combined with potash, strong attraction for oxyd of iron, and insolubility when united to that oxyd. The only substances I could think of possessing all these requisite properties were the succinic acid and sulphur; as the high price of the former precluded its use for this purpose, I determined to employ the latter. I therefore took one ounce of dry sulphuret of potash, and one ounce and a half of the best prussian blue, previously well washed and powdered, and put them into a Florence flask, two-thirds filled with distilled water; a disengagement of sulphuretted hydrogen, of ammonia, and of caloric immediately took place. The materials were boiled slowly together for three hours, occasionally replacing the water which evaporated. The whole was then thrown on a filter; what remained on the filter was black, and consisted of sulphuret of iron and undecomposed prussiate of iron. The liquid that passed through I found on trial to consist of triple prussiate of potash and hydroguretted sulphuret of potash. In order to complete the decomposition of the latter, I boiled the liquid again, for the same time as before, with another half ounce of prussian blue, and when cold filtered it. The filtered liquid (A) was now nearly colourless, and free from hydroguretted sulphuret. On pouring a little of it into a solution of oxy-sulphate of iron, I was very much surprised to find that solution changed to a deep blood-red colour, without any precipitate ensuing,

sting, instead of forming with it a precipitate of blue prussiate of iron. So unexpected a phenomenon determined me to undertake an examination of this liquid; with this view I subjected it to the action of the chemical agents mentioned in the following table.

Table I. with Liquid A.

| CHEMICAL AGENTS. | EFFECTS. |
|---|---|
| Paper stained with turmeric. | No change of colour. |
| Paper stained with litmus . . | Do. Do. |
| Potash . . . . . | No disengagement of ammonia, nor any apparent change. |
| Lime . . . . . | Do. Do. |
| Diluted sulphuric acid . . . . | An expulsion of sulphurous acid, the liquid becomes slightly opalescent. |
| Nitric acid (pure) . . . . . | The acid assumes a red colour, but this effect is not permanent. |
| Oxy-muriatic acid . . . . . | This acid loses its smell. |
| Muriatic acid (pure) . . . . . | No change. |
| Muriate barytes . . (sic or.) | A white precipitate. |
| Tincture of galls . . . . . | No change. |
| Nitro-muriate platina (ib.) . | A heavy brilliant ochre, yellow precipitate. |
| Muriate gold . . . . . (ib.) . | Dark olive-brown precipitate. |
| Nitrate silver . . . . (ib.) . | A precipitate at first white, but quickly passing to yellow, red, and lastly to brown. |
| Sulphate silver . . . (ib.) . | A dull white or stone-coloured precipitate. |
| Oxy-nitrate mercury (ib.) . | A white precipitate. |
| Oxy-nitrate lead . . . (ib.) . | A white precipitate. |
| Super sulphate copper (ib.) . | A dull white precipitate. |
| Muriate bismuth . . . (ib.) . | No precipitate. |
| Sulphate iron . . . . . (ib.) . | No change. |
| Oxy-sulphate iron . . (ib.) . | The solution assumes a deep blood-red colour. No precipitate. |

The

The effects of the sulphuric acid and of the muriate barytes clearly proved the existence of sulphite of potash in the liquid, while that of the oxy-sulphate of iron indicated the presence of some other principle to which the liquid was indebted for its peculiar characters, the separation of this principle in a pure state became therefore a necessary preliminary operation to its examination; after a few trials I succeeded in effecting this separation. The following is the process I employed.

The liquid was evaporated by a gentle heat to dryness; upon the saline residuum alcohol was poured till it ceased to extract any thing; by this means the whole of the sulphite and sulphate of potash was left behind, and the alcohol when filtered held in solution that part only which had the red tinging property with solutions of iron. The alcohol was now got rid of by distillation, and the salt it left in the retort was redissolved in water. This solution (B) gave the following results with the different metallic solutions.

Table II. with Liquid B.

| METALLIC SOLUTIONS. | EFFECTS. |
|---|---|
| Nitro muriate platina (sic or.) | A precipitate similar to that in Table I, but in a smaller quantity and longer in forming. |
| Muriate gold | Light olive precipitate, some gold reduced. |
| Nitrate silver | A grayish white precipitate, not changing colour. |
| Sulphate silver | A clear white precipitate. |
| Nitrate mercury | A copious white precipitate. |
| Oxy-nitrate mercury | A white precipitate in small quantity. |
| Nitrate lead | No precipitate. |
| Oxy-nitrate lead | No precipitate. |
| Super acetate lead | No precipitate. |
| Hyper oxy-muriate lead | A slight white precipitate. |
| Super sulphate copper | A dull white precipitate. |
| Muriate tin | No precipitate. |
| Muriate bismuth | No precipitate. |
| Sulphate iron | No change. |
| Oxy-sulphate iron | Same as Table I. |
| Oxy-sulphate manganese | The crimson colour disappears; no precipitate. |
| Sulphate zinc | No change. |
| Nitro muriate cobalt | No precipitate. |
| Nitrate nickel | No change. |

It is necessary to remark, that in the preceding Table, as well as in Table I. several of the nitrates and muriates were slightly reddened, though not in a degree to be compared with the oxy-sulphate of iron. I have not noticed this in the table, because I am not certain whether this effect was not owing to a minute portion of oxyd of iron which might have been introduced into those solutions by the acids employed to make them, as both the nitric and muriatic acids of commerce generally contain

contain some; an excess of nitric acid, even if pure, might also cause this effect, as Table I. may convince us. The solutions with which this effect occurred to me were those of bismuth, silver, mercury, lead, cobalt, gold, and platina.

The liquid B is not altered by exposure to the air.

Its effect on oxy-sulphate of iron is the same, whether this sulphate is neutral, or contains an excess of acid, or is supersaturated with carbonate of ammonia.

Sulphuric acid destroys the colour produced on oxy-sulphate of iron, provided the three liquids are in a concentrated state. If there is much water present, no change ensues.

Having obtained the tinging principle B, separate from the other salts with which it was contaminated, I asked myself to what was its formation and the simultaneous disappearance of the prussic acid, during the second ebullition, owing? I could imagine but five causes for this that were likely to have been efficient, concerning each of which I made a question to be resolved by experiment, *viz.*

Question I. Was it owing to the complete separation of the oxyd of iron from the triple of prussiate by the sulphur, and the subsequent decomposition of the simple prussiate by the heat of ebullition long continued?

Question II. Was it owing to the action of the sulphurous acid produced?

Question III. Was it owing to the action of the sulphuretted hydrogen?

Question IV. Was it owing to a combination of the prussiate of potash and sulphur?

Question V. Was it owing to the de-oxydation of the prussic acid, by the hydroguretted sulphuret?

To answer the first question, it is only necessary to attend

stand to the results afforded by long-continued boiling of the simple prussiate of potash. I shall state these results as I find them recorded by Professor Proust.

They are carbonate of ammonia, carbonate of potash, and some simple prussiate that escapes decomposition, even after four or five successive distillations; there is, therefore, no analogy between the products of this experiment and the liquid A; for had the latter contained carbonate of potash, it must have changed turmeric paper brown; had it contained carbonate of ammonia, it must have done the same, and likewise have given out ammoniacal gas when potash and lime were added; it must also have turned blue the solution of copper; and had it contained prussiate of potash, it must have produced prussiate of iron when added to the green sulphate of that metal: it will be seen by referring to Table I. that none of these effects were produced. Were further evidence necessary of the dissimilarity of the two liquids, it might be mentioned that Professor Proust poured alcohol on the saline residuum of his distillation of the prussiate, which took up a part that he found to be prussiate of potash; had any of the tinging salt B been present, the alcohol must have dissolved that likewise, and it could not have escaped his observation. We have, therefore, ample grounds for negativing the first question.

TO BE CONCLUDED IN OUR NEXT.

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*Examination of some Iron Ores, and Products of the Smelting-houses. By* M. GUENYVEAU, *Mine Engineer.*

(Continued from Page 190.)

IT would have been very desirable to have found some phosphoras in this kind of fuel; but as the quantity that was suspected to be contained in it was very small, it would

would have been necessary to have operated upon a much larger quantity than was now employed. Nevertheless, as chemistry offers the means of recognising, and of appreciating very small quantities of phosphoric acid, there is no doubt but that by operating on 80 or 100 grammes (about three ounces) of coal or coak, pulverised, and treated with several successive affusions of nitro-muriatic acid, and the whole of the phosphorus, would be converted into phosphoric acid, and thus be dissolved; so that if the coak should contain any sensible quantity of phosphorus, it would be discovered by this process. And lastly, if phosphoric acid should be searched for in the residuum left on the combustion of 200 or 300 grammes, it might be determined for a certainty whether that kind of coal or coak contained phosphorus, and in what proportion.

Composition of 100 parts.

| | |
|---|---|
| Earthy residuum | 3.0 |
| Sulphur | 0.3 |
| Charcoal | 96.7 |
| | 100.0 |

If all the coak that is made from the large lumps of coal resembles that just examined, it is one of the best fossil combustible matters that could possibly be found.

II. *Coak made from the Coal in small Lumps.*

This coak is looked upon as being inferior to the preceding; which may partly arise from the composition of the coal, and also on account of the small lumps of this fuel getting mixed with rubbish and earth, from which it is difficult to be distinguished or separated.

Fifteen grammes of this coak burned under a muffle, left a residuum of 1.73 gramme, or 11.5 per cent. The combustion was rather slow; the residuum reddish, and contained

contained a great deal of oxyd of iron. On an analysis being made, it was found to contain 7 of silica, 3 of alumine, 27 of lime, and 60.5 of red oxyd of iron.

Therefore the coak contained, in 100 parts,

| | |
|---|---|
| Silica | 0.77 |
| Alumine | 0,33 |
| Lime | 3.00 |
| Oxyd of iron | 6.66 |
| Charcoal | 89.24 |
| | 100.00 |

The composition of the coak is variable without doubt, and the proportion of iron arising probably from the pyrites which are mixed with the coal is, it is likely, still more so; but this does not interfere with the determination that lime is the predominant earthy principle. Lampadius who has made many experiments upon different kinds of coal (Recueil des Mémoires sur la Chimie) indicates lime and alumine as the constituent parts that predominate in the residuum of the combustion of coals; while silica is only found in them in very small quantity. This determination is here noticed, because it will be seen in the following pages, that the addition of these earths, lime and alumine, is detrimental in the smelting of ores by means of coak; and of course, that the coal which contains the greatest quantity of these substances is the least advantageous, independently of its being the most difficult to burn.

*Ores.*

Three sorts of iron ores are smelted at Creusot.

Chalancey ore, which is rather poor, and esteemed to be a bad kind, is smelted in a furnace 13 metres (yards) in height, and the principal dimensions of which have been given by M. Baillet, Jour. des Mines, No. 16, p. 18.

Rimmy

Rainny ore, also known by the name of (mine froide) cold ore, is added to the former, in a certain proportion which is only changed when the furnace suffers some internal derangement. It is poorer than Chalancey ore, and would yield very good iron. No earthy substance is used to facilitate the fusion of these ores. The iron that is produced from them does not possess sufficient tenacity to be used for cannons; it is used for the ballasting of ships.

The third kind of iron ore employed at Creusot comes from Franche-Comté; it is a rather rich granular iron ore, which yields very excellent pig-iron, whether it be wanted for refining into bar-iron, or for casting into cannons. This ore is smelted with charcoal in a furnace of 7.13 metres in height. Its composition is probably the same as that of the ores of the same kind that have been described by M. Vauquelin, Journal des Mines, vol. XX. p. 381.

### I. *Chalancey Ore.*

Two varieties of this ore are distinguished, one in lumps more or less large, composing the greatest part of that which is used, the other is known by the name of *mine lavée* (washed ore): the first variety is here treated of, as being the only one that was analysed.

Chalancey ore is an ore in very small grains, strongly agglutinated together, and which might be mistaken, at first sight, for a massive oxyd of iron. It is found at a small depth, in beds lying between strata of limestone. The place where it is dug is very near the village of Couches, and more than nine miles from the smelting-house. This mineral does not seem to be very homogeneous, and some parts of it appear to be only carbonate of lime coloured by a little oxyd of iron; the quantity of iron that it contains also appears to be very variable.

able. It could not therefore be expected, considering this circumstance, that the analysis of a single specimen should yield a result expressive of the average composition of the ore and other substances examined; but only that it should give some data respecting their general composition, which, although less exact, would be nevertheless of value, and would be sufficient to explain a great number of the phenomena.

An assay by the dry way, with one part and an half of glass of borax, yielded

Pig-iron.....15 per cent.

Acids dissolve this ore with a brisk effervescence. It lost 30 per cent. of its weight by calcination, which may for the most part be ascribed to the disengagement of carbonic acid. Its yellowish red colour is changed in this operation into brown red.

Constituent parts per cent.

| | |
|---|---|
| Silica | 5.50 |
| Alumine | 1.00 |
| Lime | 31.00 |
| Red oxyd of iron | 29.00 |
| Manganese, none. | |
| Chrome, none. | |
| Phosphorus | 0.21 |
| Water, Carbonic acid | 30.00 |
| Loss | 3.29 |
| | 100.00 |

Although this mineral is in fact of the same species, and probably of the same formation as the granular ores, no chrome has been found in it, nor in the pig-iron that is produced from it. Much pains have also been bestowed in search of phosphorus, in order to discover if the presence of this substance in the ore, and of course

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in the pig-iron, should be esteemed one of the causes of the bad quality of the latter; although the proportion of two thousandth-parts may appear very little, it is sufficient to have a great influence on the quality of the pig-iron, because it is condensed in that product, and that, on account of the poorness of the ore, it is necessary to smelt a great quantity in order to obtain a cwt. of pig-iron. It is also possible that the specimen that was examined may have contained less than ordinary. This conjecture will even appear more probable if the phosphorus exists in the ore in the form of phosphate of iron, and if proportionable to the quantity of iron; for the assay by the dry way yielded only 15 per cent. while the real product in the smelting-house is about 25.

II. *Riming Ore, cold Ore.*

There are very few smelting-houses in which they do not give the name of *cold ore* to some kind or other of ore; it is possible that, in the greatest number of cases, it signifies an ore that is difficultly fusible *; but it is

* In this sense a great number of cold ores exists; but probably all those which iron-masters reject on account of this quality, have only been reckoned difficult to be smelted, or even unfusible, because they have not been able to smelt them in the ordinary manner in use at that place; or, even because on mixing them with other ores, the process has been unsuccessful. Trials of this kind are not sufficient to decide, if an ore could be smelted with advantage, provided it is rich, and does not contain any principle that is hurtful to the quality of the iron. They only shew that the earthy substances which ought to be added, in order to facilitate the fusion, have not been discovered. The chemical analysis of ores, or rather the knowledge of their composition, which follows from that of the species to which they belong, provided that species has been properly examined, are the only guides in researches of this nature, in order to insure success; for there does not exist any earthy substance which cannot be melted by the ordinary heat of furnaces, when mixed with one or two other earths in a proper proportion.

not unlikely that this denomination has been given to some of the ores, the addition of which hindered the sides of the furnace from being attacked, or *burnt*, to use the expression of the smelters. It will be seen that this supposition has some foundation, in respect to Riminy ore.

This ore is in compact masses and rather hard; it does not appear like an aggregate of small grains, and by this it differs from the preceding. Its geognostic relation is not at present known. It is looked upon as very poor, but yielding iron of a very good quality. It is only employed to assist the fusion of Chalancey ore, and to bring the furnace into good order when it is embarrassed.

Constituent parts per cent.

| | |
|---|---|
| Silica | 68.6 |
| Alumine | 1.0 |
| Lime, some traces. | |
| Manganese, some traces. | |
| Red oxyd of iron | 22.6 |
| Water, Carbonic acid | 7.0 |
| Loss | 0.8 |
| | 100.0 |

Neither chrome nor phosphorus were searched after.

Before these two ores are compared, one of which is composed of lime and oxyd of iron, and the other of silica and oxyd of iron; it is necessary to examine the scoriæ that result from their fusion.

TO BE CONCLUDED IN OUR NEXT.

*Essay*

## *Essay on the Nature of Sheeps' Dung, and on its Use in dyeing Cotton of a Turkey red Colour.*

*By M.* J. B. VITALIS, *Professor of Chemistry at Rouen.*

From the JOURNAL DE PHYSIQUE.

THE process which is used at present in the dye-houses, for dyeing cotton of a Turkey red colour, was originally practised in the Levant, and is composed of a series of operations; every one of which requires to be examined by the light afforded by chemistry, if it be wished to be certain of success in this kind of dyeing.

The author being charged by the government to teach the principles of chemistry in respect to its application to the useful arts; it was necessary for him to pay particular attention to that branch of industry which forms the basis of the manufactures and trade of the first manufacturing town in France.

The manufactures at Rouen employ colours both of the bettermost and common sort. By means of certain preliminary preparations there has been given to the latter, a degree of brightness and even of solidity hitherto unknown, which was probably the reason that they were admitted to be shewn at the exhibition of the year 1806.

The middling and most numerous class of citizens must have goods of a price proportional to their means. The common colours also employ a great number of workmen, and yield a profit which other towns would be ready to seize, if the manufacturers of Rouen should in time despise it.

But it is principally from the bettermost colours, that is to say, those which are dyed in the manner of Turkey red, that that town derives its glory and riches. These

colours have opened to industrious manufacturers an immense field of inexhaustible riches. The manufacturer may now enrich his designs with that variety, that happy mixture, that elegant association and harmony of colours which is so agreeable to the sight, and will please the taste of the most delicate connoisseur, and of one the most difficult to be pleased. These are not fugacious and ephemeral colours that impose for a moment upon the eye by a false and deceitful brilliancy, but which may be said to vanish as soon as they are produced. Turkey red, and the numerous train of colours that depend upon it, such as cherry red, rose red, violet, lilac, pullicats of every shade, clove browns, amaranths, &c. are but little acted upon by the most powerful agents, and scarcely yield to the long-continued action of air, light, and soap.

It is to the employment of these colours, that the manufactories of Rouen owe the high degree of reputation which raises them above all their rivals. Fierce of their reputation, and being desirous of preserving it, they will certainly prefer the manufacture of those enamelled webs of brilliant and solid colours, which have procured them the admiration and confidence of the whole world.

The process of dyeing Turkey red is therefore an object of the highest importance and consideration to them. This process, however, although it is practised with great success in some dyehouses, still meets with obstacles in other manufactories which hinder and obstruct its progress, and occasion accidents that it would be very useful to be able to avoid.

A search has therefore been made, as far as was possible, to smoothen the difficulties and dissipitate the uncertainties

certainties that exist in the operations, which cotton destined to receive the Turkey red colour is made to undergo, by applying to each of them the torch of chemistry, and by examining them in the relations they may have with the principles of that science.

The results of the researches on the nature and use of sheeps' dung in the dyeing of Turkey red, are now presented to the Institute. The end of this essay is to settle the action and influence of the dung-vats, which are the first baths that are given to cotton in dyeing it Turkey red.

According to Le Pileur d'Apligny, in his art of dyeing cotton, neither the dung nor intestinal liquor of sheep are of any utility in fixing the colour; but it is known, says the author, that this kind of excrementitious substances contains a great quantity of volatile alkali in a disengaged state, which has the property of brightening *(roser)* the red.

Felix adopts the same opinion, in an essay on the dyeing of the red spun cotton from Greece, and on the trade in it, inserted in the Annales de Chimie, tom. 31, p. 195.

The ideas which the dyers have formed on the nature of the dung baths, are so far removed from any appearance of truth, that it is perfectly needless to mention them. How indeed, for example, is it possible to suppose that dung is only useful because of the remains of vegetable matters that it still contains, and which, by the small size of its molecules serve to divide the oil that is always mixed along with the dung to form these baths?

On recollecting what the most celebrated authors have written on the nature of animal excrements in general;

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it was impossible not to conceive some doubts at least respecting the opinion of Le Pileur d'Apligny.

In order to form a precise opinion respecting the use of sheeps' dung in the kind of dyeing here mentioned, it is necessary to pay attention to the mucous liquor which lines the internal parts of the hollow viscera, and of the canals that are open to the air, and communicate from the exterior of the body to the internal parts, as the œsophagus, trachea, intestines, &c.

This mucus, says M. Fourcroy, destined to lubricate the parts just mentioned, to keep up their softness, and the heat of their surface, and to hinder them from becoming dry and stiff, contains a kind of gelatinous albumen, but little inclined to become dry, being rather deliquescent, scarcely growing thick in the air, and keeping up the suppleness and mobility of the sides of the canals in which it is deposited.

Haller, in his immortal work upon physiology, represents the intestinal liquor as a mixture of bile, pancreatic juice, the residuum of the food, the mucus of the intestinal crypts, and a humour separated from the extremities of the arteries. This last liquor is, according to the celebrated Swiss physiologist, the most abundant, and may be looked upon as the real intestinal liquor.

The surface from whence this humour is exhaled, is an immense organ which Haller believes to be at least equal in energy and produce to that of the whole surface of the skin. The same anatomist is led to believe, from a calculation founded upon a measurement of the length and internal surface of the intestines, that there is separated about 4 chiliogrammes (8lb.) of intestinal liquor in 24 hours: which is, as M. Fourcroy remarks,

twice

twice as much as is exhaled from the skin in the same time. But the illustrious chemist who is here taken as a guide observes, that the bases of the calculation assumed by the learned Haller, are not sufficiently exact to allow us to believe with him that the intestinal liquor is twice as abundant as the transpired. It may however be presumed, that it is not far from equalling that of insensible perspiration.

All who have written upon the intestinal liquor have represented it as viscous, drawing up into threads, glairy or mucous. It has been found to be coagulable by fire, and the acids; on the other hand, it is very soluble in alkalies.

Besides the uses already mentioned, it also serves, according to M. Fourcroy, to destroy the acrimony of the food as well as to dilute and to connect the excrements.

On applying these principles to the intestinal liquor of sheep, it cannot be doubted but that this liquor exists abundantly in the residuum of the digestion of this animal and that it is to the presence of this liquor in them, that the advantages obtained from dung baths in dyeing ought to be attributed.

Volatile alkali, therefore, is not present in a disengaged state in sheeps' dung, as Le Pileur d'Apligny pretended.

Macquer observed, a long time ago, that fresh excrements do not yield any ammonia by the first impression of fire, as is done by animal substances which have undergone putrefactive fermentation; from whence it follows that ammonia is not present in recent dung, and that this alkali can only be met with in it when the balance of the original attractions is broken by putrefac-

tion, which produces new attractions to which the formation of the alkaline product is owing.

The experiment of which an account will now be given, will at the same time dissipate every doubt on this subject.

In May, 1806, 61.19 grammes (about two oz.) of fresh sheeps' dung, was distilled in a glass retort luted as usual; a receiver furnished with conducting tubes and safety apparatus was adapted to the retort, in order to receive the gaseous products. This distilling vessel was placed in a small reverberatory furnace, and heated by degrees until the bottom of the retort was red.

On the first impression of the heat, there passed over a very clear liquor. On augmenting the fire, white oily vapours were disengaged in small quantity, and speedily succeeded by some drops of a very liquid and very beautiful orange yellow oil. A second thick oil almost solid, of a blackish brown colour, and of a very empyreumatic smell followed the first oil. There passed under the bell glass during the distillation about 50 cubic inches of elastic fluids, which were known to be a mixture of carburetted hydrogen and carbonic acid gas.

The retort being broke, it was found to be lined internally with a slight carbonaceous lining, of a metallic brilliancy, and changing in the air, but only in some places, to a Prussian blue colour. At the bottom was found a tarnished black charcoal, rather solid, retaining the form of the substance analysed, without any sensible taste, but smelling absolutely the same as the smoke of tobacco.

This charcoal weighed 7.8 grammes; when it was heated in a porcelain crucible, it burned with great ease, and before the vessel was red hot. It was observed to yield oily and empyreumatic vapours, arising without

 doubt

doubt from a small quantity of oil with which it was impregnated, and which burned with a small white flame. After six hours exposure to a brisk fire, it left 3.68 grammes of a grey substance, which appeared on analysis to be phosphate of lime.

The oil, concrete as well as fluid, which was collected as mentioned above, weighed 3.91 grammes.

The liquor in the receiver was coloured and rendered turbid by some drops of fluid oil, it weighed 48.8 grammes. It rendered syrup of violets green, and at the same time it reddened tincture of litmus, but in truth only feebly.

This last property arose from a small portion of acetic acid, which was formed during the course of the distillation; and it is probable that the faculty of changing the blue colour of violets into green, is owing to the presence of a small portion of gelatinous matter, which had passed along with the vapour of the water that held it in solution.

Besides this, not the least trace of ammonia could be discovered by any reagent, on essaying the liquor in every known manner.

It follows from this experiment, that 61.19 grammes of fresh sheeps' dung yielded on distillation.

| | grammes |
|---|---|
| Acid and alkaline liquor | 48.8 |
| Gaseous fluids | 0.58 |
| Concrete and liquid oil | 3.91 |
| Charcoal and phosphate of lime | 7.8 |
| | 61.09 |
| Lost | .1 |
| | 61.19 |

From these results, it may be concluded that sheeps' dung contains much more hydrogen than azote. This conclusion may be drawn, 1°. From the great quantity of water which was yielded by the substance analysed, and which, for a certainty, was not originally contained in it. 2°. From the hydrogen collected in the bell-glass. 3°. From the oil that was obtained. 4°. From the ammonia not being produced during any part of the operation.

It therefore not only appears that ammonia does not exist ready formed in sheeps' dung, but also that it cannot exist in it in a great quantity as stated by Le Pileur d'Apligny.

But let us proceed further, and suppose for a moment that sheeps' dung should contain a certain quantity of ammonia; it is evident to all who know any thing of the process for dyeing Turkey red, that this alkali, which is so volatile, could never support the numerous manipulations, and reiterated dryings in the air or in the stoves, to which the cotton is obliged to be submitted, without its being entirely separated. It may indeed be said that the alkali becomes fixed by combining with the cotton; but then the proof of this assertion may be justly required; and so far from this being able to be furnished, experience will speedily show the contrary.

Even if the existence of ammonia in the residuum of the digestion of sheep was allowed, it still would be equally void of foundation to pretend that this alkali would act in the dyeing of cotton of a Turkey red, by the property which is gratuitously ascribed to it of brightening (roser) the cotton; that is to say of enlivening the red tint yielded by the madder, and giving to it fire, brilliancy and liveliness, for that is the sense in which

which the term, *roser*, is used in the dyehouses of Rouen. The effects now spoken of can only be produced by forming from white Marseilles soap and muriate of tin, a metallic soap in which the oxyd of tin is held in solution by soda. It would be useless to attempt to attain the same end by employing ammonia, whose existence has also been shown to be a chimera.

So that the properties which are ascribed to the ammonia contained, as it is said, in large quantities in sheeps' dung are as imaginary as the being to which they are ascribed. It therefore becomes necessary to search in some other principle for the cause of the effects produced by baths of sheeps' dung in dyeing Turkey-red.

But this principle can be no other than the albumino-gelatinous matter abundantly contained in the excrements of sheep. It is only necessary to pay attention to the manner in which it is used in the dyehouses, in order to be convinced of this.

The dung is first macerated, for a longer or shorter time, in a cold solution of soda, marking about 4° by the hydrometer. The intention of this maceration is evidently to bring about the solution of the albumen and gelatine by means of the alkali. Afterwards a certain quantity of this solution, strained through a sieve and diluted with water of soda at 2° hydr. is mixed with fat or mucilaginous olive oil; by which means there is formed a sort of liquid animal soap, with which the cotton is carefully impregnated.

In this preparation, the cotton by combining with the albumen and gelatine approaches in some degree to the nature of animal substances, which are well known to have a much stronger attraction for colouring matters

than

than vegetable substances have. The combination appears to be favoured by the oily principle which is combined at the same time with the cotton.

It may thus be seen why authors who have written on Turkey red recommend not only the use of dung, but also of the intestinal liquor of sheep, which would be still more advantageous, if it was possible to procure it in sufficient quantity for the use of dyers.

Experience is evidently in favour of the theory just mentioned.

Fresh sheeps' dung was macerated for 4 or 5 days in a ley of soda at 4° hydr: it was then filtered, and a reddish brown liquid was obtained. The alkali was then got rid of by adding very dilute sulphuric acid, and an abundant light precipitate appeared, and was deposited at the bottom of the vessel, after having occupied for some time the whole bulk of the liquid.

In order to leave no doubt on the nature of this precipitate, it was collected upon a filter, and after being well washed with cold water, it was boiled in a phial with pure water for about an hour, and the reddish yellow liquor was then decanted, into which a solution of tannin being poured, a precipitate was formed that plainly shewed the presence of gelatine.

The albumen coagulated by the action of caloric remained at the bottom of the phial in the form of small, soft, and spongy lumps; and if a judgment may be formed from the quantity of undissolved matter in the water, although it was renewed three or four times, albumen is much more abundant than gelatine in sheeps' dung. It is not far from the truth to say, that the proportion of the albumen is superior to that of the gelatine in the ratio of at least 3 to 1. But particular circumstances

stances have hitherto prevented the exact determination of this point.

In order to remove every doubt on this subject, it was attempted to supply the place of dung baths by an alkaline solution of white of egg, or albumen, and perfect success was obtained, both with bettermost and common colours. They all acquired much more solidity than when the use of natural or artificial dung baths was neglected.

This last observation, founded upon reason and experience, completely overturns what Le Pileur d'Apligny advanced, when he said that the dung or the intestinal liquor of sheep are of no use in respect to the fixing of the colour.

The essential principles brought forward in this essay may be reduced to the following.

1°. Sheeps' dung used in dyeing Turkey red does not contain ammonia.

2°. Ammonia has not the property of enlivening (roser) Turkey red.

3°. Sheeps' dung acts only by the albumino-gelatinous matter that it contains; which serves to reduce the cotton to the nature of animal substances, and of course to dispose it to unite more solidly with colouring matters than before.

4°. The dung and intestinal liquor of sheep are very useful for fixing colours in general, and particularly Turkey red.

## *List of Patents for Inventions, &c.*

(Continued from Page 192.)

WILLIAM COTTON, of Limehouse, in the county of Middlesex, Manufacturer; for a method of regulating the texture of all kinds of cloth in the process of weaving. Dated January 15, 1810. Specification to be enrolled within four months.

WILLIAM MURDOCK, of Soho Foundry, in the county of Stafford, Engineer; for a method or process for boring and forming pipes, cylinders, columns, and circular disks, out of solid blocks and slabs of stone of any kind or description. Dated January 15, 1810. Specification to be enrolled within two months.

THOMAS BAYLEY, of Birmingham, in the county of Warwick, Brass-founder; for certain improvements in sliding pullies for window-blinds and for other purposes. Dated January 15, 1810. Specification to be enrolled within two months.

PETER COX, of Fairford, in the county of Gloucester, Civil Engineer; for certain improvements on the thrashing machine. Dated January 23, 1810. Specification to be enrolled within two months.

JOSEPH MANTON, of Davies-street, Berkeley-square, in the county of Middlesex, Gun-maker; for an improvement in telescopes. Dated January 23, 1810. Specification to be enrolled within two months.

THE

# REPERTORY

OF

# ARTS, MANUFACTURES,

AND

# AGRICULTURE.

No. XCV. SECOND SERIES. April 1810.

*Specification of the Patent granted to* MARC ISAMBARD BRUNEL, *of Portsea, in the County of Southampton, Gentleman; for an Invention of a new Mode of cutting Veneers or thin Boards by Machinery.*

Dated September 23, 1806.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Marc Isambard Brunel do hereby declare that my said invention of cutting veneers or thin boards, consists in separating the wood by means of a sharp instrument, forming part of an engine which I specify as follows:

Fig. 1, (Plate XIV.) represents the plan of the engine; Fig. 2, the longitudinal elevation; Fig. 3, a transversal elevation; and Fig. 4, a plan of carriage; A, Figs. 1 2 and 3, represents the cutter of the engine. This cutter, which might be made of one single piece, is, on account of its length, represented as being composed of several pieces or plates of steel 1 2 3 4, &c.;

Fig. 1, held together and fastened by means of screws 6 7 8 9, &c.; Figs. 1 and 2, and of a clamp C, Fig. 3, to a frame B, Figs. 1 2 3: it must be observed, that these pieces or plates of steel can be pushed out in proportion as they wear out. This frame B forms a slider, which is to move along the two rails D D, Figs. 1 and 3: as the two rails D D require a considerable degree of strength, they extend by means of brackets along each side of a pipe E, Figs. 1 2 3, together, with which they form one solid body. This pipe, having a flanch at each extremity, is fastened to two standards F F, Figs. 1 2 3, which are strongly bolted through their base to a platform G, Figs. 1 2 and 3. The frame or slider B is connected by means of a rod *f*, Figs. 1 and 2, to the machinery, by which it is to be put and kept in motion. The part of the engine which carries the wood is composed as follows: H, Figs. 1 2 3 and 4, represents a cast-iron bed, bolted to the platform G, Figs. 1 and 3. The upper edge of each side of this bed terminates into a projecting angular rail J J, Figs. 2 and 4. K, Figs. 1 2 3 and 4, represents a cast-iron frame, which may be denominated a carriage intended to slide on the bed H, by the assistance of a screw L and rack M, Figs. 1 and 4. This sliding motion of the carriage, guided by two clamps N N, Figs. 2 and 3, is to propel the wood towards the cutter. When the veneer or thin board has been separated from the piece of wood by the operation of the cutter, the carriage is removed back in order to clear the wood from under the cutter. The piece of wood is then to be elevated proportionally to the thickness of the veneer which is next to be cut, by means of a parallel motion disposed as follows: The table O, Figs. 1 2 and 3, upon which the piece of wood is

placed,

Fig. 3.

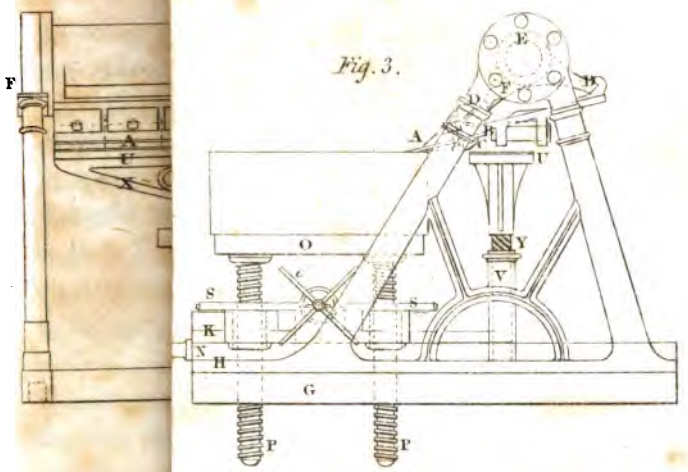
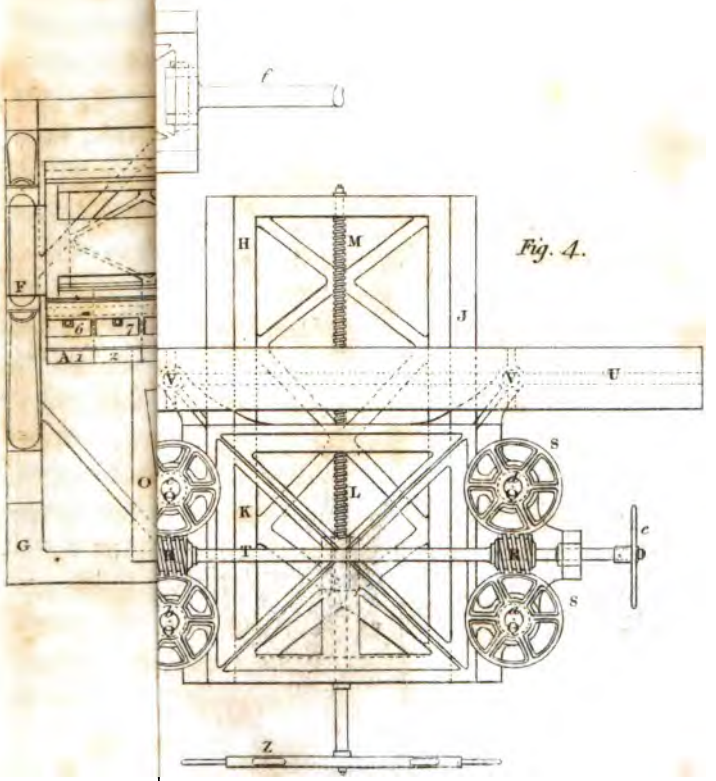



Fig. 4.



placed, is supported by four screws P P, two of which are seen in the Figs. 2 and 4. These screws P P, pass through four nuts, Q Q Q Q, Fig 4, let in sockets, which make part of the carriage K. It is evident that by turning these nuts Q Q, the screws P P, and consequently the table O, will be elevated or lowered at pleasure. The four nuts are turned altogether and at the same time by the assistance of endless screws R R, Fig. 4, which, being fixed on the same spindle T, Figs. 2, and 4, act upon the wheels S S, Figs. 1 2 3 and 4. These wheels, S S, are connected with the nuts Q Q; the two screws placed at *a* and *b*, Fig. 4, are right hand, and the two others, at *c* and *d*, are left hand screws (see also P P, Fig. 3.) In lieu of a long cutter similar to that which is herewith described, another might be substituted (see Fig. 5.) A, Fig. 5, represents the cutter; B the frame or slider: both answer to the section of the same parts represented under the corresponding letters in Fig. 3. This slider B is in this case intended to be moved from one end to the other of the rails D D.

It is obvious that the cutter, whether long or short, requires to be kept perfectly flat and true with respect to propelling motion of the carriage K, and the parallel motion of the slider B, and also very sharp. In order to obtain these three points, I have added to the engine a lap U, Figs. 2 3 and 4, upon which the cutter is to be ground when requisite; VV, Figs. 3 and 4 represent two uprights fixed on the front of the carriage K. The frame X X, Fig. 4, of this lap is supported by means of two steady pins let into the uprights; it is elevated or lowered at pleasure by the assistance of the screws Y Y, Fig. 2; the lap U is brought under the cutter by sliding back the carriage as much as is necessary. The engine

before specified is used and managed in the following manner: The piece or pieces of wood to be cut into veneers or thin boards are placed or fastened on the table O by means of cement or glue; in the latter case, the top of the table O ought to be lined with wood. The slider B being supposed in motion, the workman attending the engine adjusts at first the table to a proper degree of elevation, propels the carriage by the assistance of the wheel Z, Figs. 1 2 3 and 4; the workman, guided by the apparent effect of the cutter, continues to force the carriage until the veneer is entirely separated; he then moves back the carriage with the assistance of the same wheel Z, and prepares for another cut by elevating the table as much as is possible. This is accomplished by turning the spindle T, Figs. 2 and 4, with the assistance of the handles *e*, Figs. 1 2 3 and 4, which being done, he can proceed as before.

In witness whereof, &c.

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*Specification of the Patent granted to* JOHN WHITE, *the Younger, of Whitehall Wharf, in the Parish of St. Margaret, Westminster, Gentleman; for the Discovery of a certain Substance, which is capable of being converted into Statues, artificial Stone, Melting-pots, Bricks, Tiles, Baker's Pans, Chimney-pots, Garden-pots, and every Description of Pottery.* Dated November 27, 1809.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John White do hereby declare that the nature of my said invention or discovery, and the manner in which the same is to be performed, are particularly described as follows; that is to say: Instead of the potter's clay,

clay, or other argillaceous earths which are dug out of the ground, and used and applied for manufacturing and making bricks, tiles, and other articles of pottery; I do take from the bed or channel of the River Thames, or from the creeks, or openings, or docks, or other cavities or places into which the waters of the said river are suffered to enter or flow within or near the Cities of London and Westminster, the Borough of Southwark, and parts adjacent within the flow of the tide, such portions as I may have occasion for, of the deposit or alluvial soil or siltage which subsides in the said river and the creeks, openings, docks, cavities, and places aforesaid; and which, by various researches, experiments, and observations, I have found to consist for the most part of argillaceous earth, clay, or chalk, and sand from the uplands, along with materials of the nature of pit-coal, ashes, sand, and with the remains of the organised matters from these extensive towns, and which is the substance first hereinbefore mentioned. And I do select in preference such parts, samples, or masses of the said deposit, or alluvial soil, or siltage, as upon examination I find to be most clear of worms and aquatic animals, and most plastic and fit for the purpose of making statues, artificial stone, melting pots, bricks, tiles, sugar baker's pans, chimney pots, and garden pots, and other articles of pottery as aforesaid. And I do according to the intention or purpose to which the said deposit, or alluvial soil, or siltage, is or may be required to be applied, modify, alter, and improve the same, by the addition of such proportions of natural clay and sand, or either of them, as may be needful, and as may easily be ascertained by any competent workman, by such trials as in all such cases are needful to be made in the art of

pottery

pottery and brick-making; and I do place and dispose the said parts, samples, or masses, when so selected or taken upon a sloping bank or support, in order that the water may drain therefrom; and I do use and apply the same with or without the modification and improvements aforesaid, for manufacturing and making statues, artificial stone, melting pots, bricks, tiles, sugar baker's pans, chimney pots, garden pots, and every description of pottery, by the methods, and with or without the glazing and colouring materials, and with the use of such implements, tools, furnaces, and structures, as are commonly and respectively practised, used, and employed according to the nature of the several exigencies requiring or demanding the same.

In witness whereof, &c.

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*Specification of the Patent granted to* JOHN FREDERICK ARCHBOLD, *of Great Charlotte Street, in the County of Surrey, Gentleman; for a Method of converting Salt or Sea-water into Fresh-water, both on Land and on-board of Ship at Sea.* Dated April 18, 1809.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said John Frederick Archbold do hereby declare that the nature of my said invention and the manner in which the same is to be performed, is described and ascertained in the following description thereof; that is to say: My invention is for producing pure fresh water from salt or sea-water by distillation, on a new principle and by filtration; and I perform my invention as follows: First, as to a general principle of distillation, I place in contact with a fire, stills of a construction which I shall now describe; each still has an outward case of metal,

between

between the interior sides and bottom of which, and the exterior bottom and sides of the still, a space is left vacant, but the still—inserted into the case in such a manner that there shall be no egress for the steam from the case, except by a safety valve. The head and neck are affixed to the still; thus the water in the cases not having the pressure of the atmosphere, will rise much beyond the boiling heat and boil the stills which are inserted into them, and there being no egress for the steam from the case, except by the safety valve, a small fire will suffice to keep up this degree of heat, and of course keep the stills always boiling. From that part of the case which comes in immediate contact with a fire a flue may be inserted, which, making some horizontal revolutions along the bottom, may pass out into the chimney. The back also of the fire-place can be a narrow boiler which may communicate with the cases of the still. When performed on-board of ship, a reservoir of salt water is placed upon the deck of the vessel (through which reservoir the chimney of the fire may pass and impart its heat), and from thence pipes, having a cock attached to each, lead into the cases and stills for the purpose of their supply. From the necks of the stills pipes are brought conducting the steam into vessels for cooking the provisions, &c. The range has two metal doors in front, each of which doors is attached by hinges to iron bolts; which bolts fit into staples affixed in the side of the range; so that when the fire is not wanted for the purpose of cooking, it can be entirely enclosed by these doors; but when required, the doors can be drawn out the length of the bolts fitting into the staples at the side of the range, and form a screen between which and the fire the meat, &c. can be roasted. For

the

the purpose of condensing on-board of ship, the tube containing the steam to be condensed may pass through the ship, and along any part of the outside of it which lies immediately in the water, and again entering the ship, it discharges the condensed matter into any vessel which may be designed for its reception: after the sea-water has been distilled in this manner, it is passed through a filterer, of which the following is a description: a small cylindrical case is made of tin or other metal, and being filled with pounded charcoal, each end is stopped by a circular cover perforated with holes fine enough to prevent the charcoal from passing through. One end of this case is inserted into a cask also partly filled with pounded charcoal, and the water being poured into the cask filters out through the case.

In witness whereof, &c.

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*Specification of the Patent granted to* RANDOLPH TSCHIFFELI DE ROCHE, *for certain Improvements in the Processes of Brewing.* Dated September 26, 1809.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Randolph Tschiffeli de Roche do hereby declare, that my said invention is fully described and ascertained in manner following; that is to say:

These discoveries in the art of brewing consist;

1°. In a method of colouring porter by malt only, without losing any of its fermentescible substance, by means of roasting the skins or husks of the malt after they have been separated from the ground malt.

2°. In making from malt, vinegar almost entirely deficient in essential oil, which will be previously separated from the malt itself.

3°. In

3°. In brewing malt wine, *(vin du malt,)* with the same advantage as has been just mentioned in respect to vinegar.

4°. In making wash for distillation, in such a manner as to obtain a spirit which shall be more neutral than that formed by the common process.

First process. I separate by a mill, according to the usual method, the skins from pale dried malt: if these skins have any of the ground malt mixed with them, I repass them through the mill. The skins being roasted to a coffee colour, will give a very fine colour to porter. The necessary quantity for a quarter of malt is about 42lbs. of skins, which, when roasted, will weigh about 31lbs.: if a smaller quantity of the skins be used, a weaker colour will of course be obtained.

The colour is extracted from the roasted skins either by mixing them with the ground malt, previous to its being brewed, which will hinder the ground malt from having so great a tendency to clot together, or by infusing them in the cistern of cold water, by which means the colour will be extracted, the water will be rendered more proper for brewing, and it will filter very clear; or by making an infusion of the skins in warm water, or even by boiling them in water; or, lastly, by first moistening the skins as long as they will imbibe any water, and then mixing them with beer which is already made, and stirring the whole together, once a day, for about a week. This last method is the most efficacious, and it will at the same time clarify the beer.

The main fact, however, which I consider as the essential part of my discovery in regard to brewing of porter, is, that the roasted skins of malt will suffice to colour the porter, or, if used in less quantity, would

form a colouring substance in aid of other colouring means, without my pretending in any way to fix upon the choice of the different manners in which it may be reduced to practice.

2°. Vinegar made from malt should be brewed only from the pure ground malt carefully separated from the skins. This vinegar will, for a certainty, contain a less quantity of essential oil than at present, because this oil principally resides in the acrospire, which will be separated at the same time. The parts which are separated may be used to colour porter.

3°. Wine brewed in the same manner as for vinegar will possess the same advantage.

4°. The spirit distilled from wash brewed in the same manner will also be more neutral or clearer than at present.

The only apparent difficulty in my method of brewing is, the care that must be taken in order to prevent the ground malt from clotting together. In brewing porter, however, the admixture of the roasted husks diminishes the cohesion of the malt; the same end is obtained by adding the roots (commonly called malt-dust) of the malt to the flour thereof, which also gives the beer more flavour. But there will not, in any case, be any danger of the ground malt clotting together if the water is put first put into the mash-tun, and the ground malt sifted into it, or by any means put in a divided state, which may be very easily executed.

In witness whereof, &c.

*Description*

*Description of an Eye Bath, to clear the Eye from extraneous Matters, and to assist the Sight. By Mr.* JOHN DUCKETT ROSS, *of Princes-Street, Leicester-Square.*

With Engravings.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

*Fifteen Guineas were voted to Mr.* ROSS *for this Invention.*

BEING employed in the jewellery business, I have frequently suffered greatly from extraneous substances getting into my eyes, at different times, whilst I have been at work; and I have witnessed many accidents of a similar kind, which have happened to enamel-grinders, turners in metal, jewellers, lapidaries, and other artificers. These circumstances led me to attempt some means which would relieve such misfortunes, and also strengthen my own eyes, which were naturally weak. I have now succeeded in inventing an eye bath, possessing all these advantages; and which I beg leave to lay before the Society of Arts, &c. and hope it will be patronized by them.

The machine I have sent forms an elegant ornament for a lady's or gentleman's dressing-room, and has been found very serviceable in use, of which I will furnish the Society with certificates.

I thought it might not be improper to acquaint you, that Mr. Carpue has, according to a promise he made me, this day honoured my invention, by expressing his fullest satisfaction of it before the Medical Board; and that surgeon-general Keate, and Mr. Gillham, late chief surgeon to the Coldstream regiment, have, in con-

sequence, favoured me with their orders; and I am further assured, that there is great hopes of my invention being generally adopted for the use of the army and navy.

Certificates were received from Mr. Charles Silberred, Optician, Aldgate,—Mr. Richard Carpenter, Engraver, Aldgate, High-street,—Mr. Edward Seymour, Engraver, &c. Greek-street, Soho,—Mr. William Whitefield, Engine-turner, Silver-street,—R. Squirrell, M. D. Soho-square,—Mr. Robert Salmon, of Woburn,—Mr. J. C. Carpue,—Mr. Edward George Adams, High-street, Mary-le-bone,—stating, that they considered Mr. Ross's invention for the eyes calculated to produce many excellent advantages to the public, and likely to become extensively useful.

## Reference to the Engraving.

Fig. 2, (Plate XV.) is a perspective view of the eye-bath, which is preserved in the Society's Repository. This apparatus is supported on a pedestal, or tripod. The bath part is represented on a larger scale in section, Fig. 3, where *a b* represents a glass vessel, which has a neck at the lower end, and an aperture at its vertex, as is shown in the plan, Fig. 4, to fit the eye. The neck is cemented in a brass tube *c c*, which is supported, by being screwed into an ornamental piece of brass work at the top of the pedestal. This tube encloses a common pewter syringe, the end of which is cemented into the neck of the glass vessel, as the section sufficiently explains. The handle *e* of the syringe, has a piece of brass screwed to it, which slides up and down, between two pieces of brass at *h*, in the pedestal, and a glass dish

dish *i* is fixed below the frame, to receive any water which may be spilled by accident. When the instrument is used, the glass vessel is to be partly filled with water, (or any other liquid with which the eye is to be syringed,) so as to cover the orifice of the syringe; the patient then places his eye over the aperture in the glass vessel *a b*, and suddenly lifts up the brass slider at *h*, to which the handle of the syringe is fixed, so as to force the liquor contained in the syringe through that in the glass vessel into the eye; the liquor which covers the point of the syringe takes off the force with which the liquor would be thrown into the eye, so as to render the operation not in the least painful. A more commodious, though less elegant form of the same apparatus, is shown in Fig. 1. The syringe *a* is here placed horizontally, its point being turned up. It is soldered into a vessel of japanned tin, and the glass *e*, which is here globular, is laid loose on the japanned vessel *d*, which contains the liquor that surrounds the point of the syringe. This apparatus Fig. 3, is intended to be placed on a table when used.

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## *Improved File for Receipts and Letters.*

*By* RICHARD WHITE, *Esquire, of Essex-street.*

With Engravings.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

*The Silver Medal was voted to Mr.* WHITE *for this Invention.*

I SEND herewith the model of a file for papers, which I think will be found preferable to any in common use.

A voucher

A voucher cannot be disengaged from the common file without defacing it by cutting it off, or by removing many others to get at it; and to return it to its proper place is attended with more trouble and inconvenience. All this is avoided by the contrivance in the file now sent, the wire of which is passed through a cylinder, and fastened by a screw at the bottom.

When a particular paper or voucher is wanted, remove those which are above it from the cylinder upwards to the wire, which is first to be disengaged by unscrewing it, the paper sought for will then be the uppermost on the cylinder, and of course easily taken off: when that is done, return and fasten the wire as before, pressing down the papers from the wire to the cylinder. To return the voucher, the same operation is to be repeated, and the voucher restored to its proper place.

## Reference to the Engravings.

This invention consists of a metal tube *a*, Fig. 6, (Plate XV.) with a convex circular plate soldered to its lower end, to keep the papers from slipping off the file, and having attached to its under side a piece of metal *b*, Fig. 7, with a screwed hole in it, to receive a screw on the end of the wire *c*, Fig. 8, the other end of the wire being formed into a hook, sharpened at its point, to receive the papers as usual; when any paper is wanted to be taken off the file (instead of taking off those above it, which cannot be replaced again without much loss of time and trouble, or, which is still worse, tearing it off) the uppermost papers are to be slipped up towards the top of the wire *c*, which must be unscrewed, and with the papers upon it removed, as shewn in Fig. 8; the paper

paper wanted may then be taken away, the wire replaced again into the tube *a*, and screwed fast, and the other papers drawn down the tube as before. The upper end of the tube *a* should be made conical, and its edges sharp, the better to suffer the papers to pass over it. A section of the tube and female screw *b* beneath is shewn separately at Fig. 7. The papers are shewn in Fig. 5, in the situation they are commonly placed upon the cylinder, with the wire within the cylinder.

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## *Method of teaching to write on a cheap Plan, by Means of Copies engraved on Slates. By Mr.* THOMAS WARREN, *Junior, of Buckingham-street, Adelphi.*

With Engravings.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

*The Silver Medal was voted to Mr.* WARREN *for this Communication.*

THE great utility of engraved slates in instructing the children of the poor, particularly in the art of writing, has been amply proved in several respectable charity-schools at Bury St. Edmund's, also in many private families for the last nine months.

This invention occasions great saving in writing-paper, pens, ink, and labour in teaching.

In making use of these slates, the slate pencil is recommended to be placed in a quill, and to be held exactly after the manner of a pen, by which means the hand is made pliant, preparatory to the use of that instrument on paper.

Small

Small slates without capitals, which are the sort recommended to schools in general, are sold for fifteen shillings the dozen, by one of which all the children in a family may learn to write; and with care it will last for ages. Small Slates, with capital letters, are sold at one guinea the dozen. They may be procured on my account from Messrs. Champante and Whitrow, Stationers, Jewry-street, Aldgate; and Messrs. W. and C. Child, Lower Thames-street.

The method I recommend in making use of my small slates, with the two additional sums engraved upon it, is to cut off with the pencil the three lower lines for the first sum, then four lines, then five, &c. by which means the two sums answer the purpose of many; I have proved this slate to be of great use in schools. The large slate, with the first four rules of arithmetic engraved upon it, I recommend as a useful article in private families, as by it children may be exercised in those rules with very little trouble.

An addition sum may be cut upon a slate, to do for the purpose of addition, subtraction, multiplication, and division, by setting the lines at a considerable distance from each other, and making the upper lines the largest numbers for subtracting, but it makes rather a complex article, and examples for children cannot be too plain.

I have prepared some slates with designs engraved upon them for learning to draw from, but I do not consider this as a very important article.

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Certificates were received from Mr. John Powell, of Islington, and sixty other respectable persons, stating that they think Mr. Warren's invention is likely to prove of considerable public utility.

REFERENCE

Fig. 1.

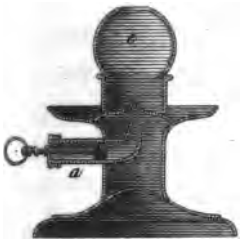



Fig. 2.

Fig. 4.

Fig. 3.

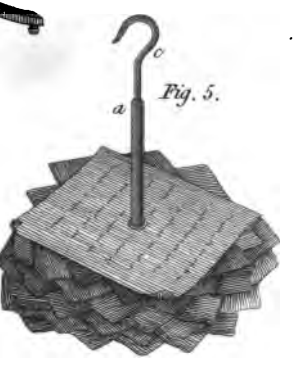



Fig. 5.

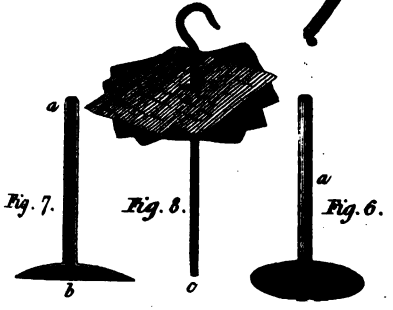
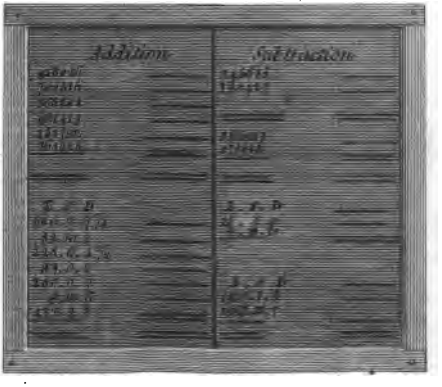



Fig. 9.

Fig. 10.



REFERENCE TO THE ENGRAVING.

Fig. 9, (Plate XV.) represents one of the smaller slates, on which the numerals 1 to 9 are engraved on the slate; faint horizontal parallel lines are drawn across the slate, within which the scholar is to copy with a slate pencil the figure at the beginning of that line; he may at discretion proceed to copy one figure in the different lines on the slate, or to copy each figure in each line. When the lesson is completed and examined by the master, the figures made by the scholar with the pencil are rubbed out, and he proceeds with a second lesson as before.

By reversing the slate, the small letters of the alphabet will serve for lessons in a similar manner.

Fig. 10 shews one of the larger slates with examples in addition and subtraction, these lessons may be varied at the pleasure of the master, by the methods pointed out in Mr. Warren's preceding letter.

The master of a large school may have each slate engraved in different figures, by which means an infinite variety of lessons may be furnished.

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## *Experiments and Observations on the Prussic and Prussous Acids.*

*By Mr.* R. PORRETT, *Jun. of the Tower.*

(Concluded from Page 238.)

IN order to answer the second question, I passed sulphurous acid gas for a long time through a solution of triple prussiate of potash; the prussic acid was expelled, and sulphate of potash formed; but this sulphate was not mixed with any tinging salt. On the supposition

that the disappearance of the prussic acid, in the liquid A, might have been owing to its having been expelled entirely by the sulphurous acid, and that the tinging liquid resulted from the mutual action of the other principles, namely, the oxyd of iron and hydroguretted sulphuret of potash: I subjected a mixture of these materials to long boiling, but could not by this means produce a liquid that tinted oxy-sulphate of iron red. Sulphurous acid gas, passed through water in which Prussian blue was diffused, did not in the least affect that compound. These experiments completely refute the opinion on which the second question was grounded.

To enable me to reply to the third question, I passed sulphuretted hydrogen gas for several hours through a solution of triple prussiate of potash, on which it was found to have no effect.

We shall be little disposed to allow that there is any foundation for the fourth question, when we consider the circumstances of the last-mentioned experiment, in which sulphur in the state of the most minute division was offered to the triple prussiate, without any combination ensuing; and also when we compare the effects of the metallic solutions in Table II. with those which would ensue with liquids containing sulphur. But, if any doubt should still be entertained on this subject, the following experiment will perhaps remove it: Into a solution of prussiate of mercury throw some pieces of phosphuret of lime, the oxyd of mercury of this prussiate will thus be reduced and separated from the liquid which is to be filtered; some of this liquid poured into carbonate of iron turns it red, the red colour soon disappears, and a white precipitate begins to form; this white precipitate soon changes to green, and if a little

nitric

nitric or oxy-muriatic acid be now poured upon it, it becomes a perfect blue prussiate of iron. This experiment, in which a liquid turning a solution of iron red was produced without the employment of a particle of sulphur, goes very far to negative our fourth question; and when considered in conjunction with the preceding ones, we can hardly do otherwise than dissent from the supposition which gave rise to that question.

But if the experiment last adduced tends to refute the fourth question, it very strongly supports the fifth; for the changes of colour observable were undoubtedly owing to successive stages of oxydation by the contact of the atmosphere. In confirmation of this question, it may likewise be asserted, that the long boiling with the hidroguretted sulphuret is a powerful de-oxydating process. But it will be said to me, if it is really true that the prussic acid has been de-oxydated by this process, you ought to be able to recompose that acid from the solution B by oxydation. This struck me very forcibly; and being anxious to give this last proof of the truth of my deductions, I attempted the recomposition of this acid by several oxydating processes for some time without success: I had at last, however, the particular satisfaction of succeeding completely by the agency of nascent hyper-oxy-muriatic acid. The method I employed was the following:

A little hyper-oxymuriate of potash was put into the bottom of a glass tube. Over this some of the liquid B, mixed with a few drops of diluted sulphuric acid, was poured. The heat of a candle was then applied to the bottom of the tube, and as soon as a violent action commenced, the heat was withdrawn: by this process the prussic acid was reproduced, and was proved beyond

the possibility of a doubt by the formation of blue prussiate of iron, when poured into a mixture of green and red sulphate of that metal. Blue prussiate may also be produced at once, by substituting for the diluted sulphuric acid, a solution of green sulphate of iron, with excess of acid.

Having thus succeeded in proving that the tinging principle of the liquid B was sub-oxydised prussic acid, my next object was to obtain that principle in a free state; for we must recollect that we have hitherto considered it only in combination with potash, with which it formed a neutral salt: this circumstance gave me reason for supposing it an acid, and I therefore determined to attempt its separation by abstracting its base by a stronger acid. The following was the process I employed for the purpose.

The liquid B was evaporated nearly to dryness, and put into a retort with diluted sulphuric acid, a receiver was then adapted to it, and about two-thirds of the liquid distilled over by a gentle heat; what remained in the retort was sulphate of potash. The receiver contained a colourless liquid, with a faint, sour, disagreeable smell, and a decided acid taste. This liquor I have named in conformity with the principles of the new nomenclature, *prussous acid*, and its salts *prussites*, of which the liquid B contained one in solution, namely the prussite of potash.

The effects of the prussous acid on the earthy and metallic solutions, as far as I have tried them, are noted in the following table.

Table

Table III. with Prussous Acid.

| CHEMICAL AGENTS. | EFFECTS. |
|---|---|
| Muriate lime | No change. |
| Muriate barytes | No change. |
| Muriate gold | The gold precipitated metallic. |
| Sulphate silver<br>Nitrate silver | Copious white precipitate. |
| Prussiate mercury | No change. |
| Nitrate mercury | Copious grayish white precipitate. |
| Oxy-nitrate mercury | Very slight precipitate white. |
| Oxy-sulphate iron | Solution turns blood-red, no precipitate. |
| Nitro-muriate platina | No precipitate. |
| Nitrate lead | No change. |
| Oxy-nitrate lead | Solution becomes red, but hardly any precipitate formed, unless heated, in which case a copious white precipitate ensues. The red colour disappears, a rapid action takes place between the two liquids, and some of the nitric acid of the solution is decomposed. |
| Hyper oxy-muriate lead | A slight precipitate, probably of muriate of lead. |
| Super sulphate copper | Solution becomes slightly turbid. |
| Muriate bismuth<br>Nitrate nickel<br>Muriate tin<br>Nitrate cobalt<br>Sulphate iron<br>Sulphate manganese<br>Sulphate zinc | No precipitate. |

I cannot conclude this part of my memoir without giving a more simple and expeditious process for preparing prussite of potash, than that which I at first discovered. It is the following:

Pour

Pour a solution of prussiate of mercury into hydroguretted sulphuret of potash, till the mutual decomposition of the two liquids is completed; prussite of potash is instantly formed, and may be separated by filtration from the solid combination of the sulphur and mercury.

I wish also to observe, that the proportion of Prussian blue I have mentioned for boiling with the sulphuret is much larger than is necessary, as I have since succeeded in obtaining prussite of potash when the proportion of Prussian blue was only equal to that of the sulphuret, but long boiled with the latter in two distinct and equal portions. The prussite of potash thus obtained is, however, mixed with a much larger quantity of hydroguretted sulphuret than when a greater portion of Prussian blue is employed.

Whether the prussous acid can be applied to any use, time and future experiments must decide. It appears to me, to be a very delicate test of silver and of iron in solution.

The preceding experiments, by proving the presence of oxygen in prussic acid, give it a stronger claim than it before possessed for being placed among the acids.

The prussous acid possessing stronger acid properties than the prussic is a curious, though not a solitary, instance of the effect of oxygen in diminishing acidity, when its quantity exceeds a certain fixed proportion; in this respect the prussic acid is analagous to the oxymuriatic.

To recur to the attempt which gave rise to the researches that are the subject of this memoir, I beg leave to state, that I have succeeded in producing pure triple prussiate of potash, by stopping the process before the change which produced the prussite ensued, and by subse-

subsequent purification of the lixivium from sulphates and sulphites, by acetate of barytes; from sulphur by acetate of lead; and, lastly, from the acetate of potash thus formed by chrystallization; but on account of the complication of this process, I hesitate to recommend it for general use.

Wishing to give every information tending to ensure success to those persons who may be inclined to repeat my experiments, I am induced to request the Society to allow the enclosed paper to be considered as a Supplementary Note or Memorandum to the Memoir on the Prussic Acid, which I had the honour to submit to their notice.

It is essential to the success of the experiment, in which the prussic acid is regenerated from the liquid B by the nascent hyper-oxygenised muriatic acid, that the excess of acid remaining in the liquid, after the oxygenising process, should be neutralized by an alkali previous to pouring it into the solution of iron, which should likewise be perfectly neutral.

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*Certificate in favour of Mr. Porrett's Prussic Acid.*

Gentlemen,

I beg to state that I have repeated the greater part of the experiments related in Mr. R. Porrett's Memoir on the Prussic Acid, and find them correct. I have no hesitation in saying the discovery of the new acid is a source of merit to himself and utility to science.

Yours, &c. JOHN DUNSTON.

*Old Broad-Street, May 6, 1809.*

*On*

## *On the Sulphuret of Lead.* *By M.* DESCOSTILS.

From the MEM. D'ARCUEIL.

OF all the labours which have been published on metallic sulphurets, none to my knowledge have been directed to the action which elastic fluids exert on these compounds. M. Guenyveau, and since him M. Gay Lussac have indeed examined the changes produced on sulphurets by the contact of air assisted by heat; but their researches have not been extended to other gases.

I conceived it might be of some use to become acquainted with the effects of aeriform substances on the bodies, which he has made the subject of his enquiries, particularly with those of the gasses which are liable to be given off during the treatment of sulphureous ores. It appeared to me, that the explanation of most of the phenomena which occur during metallurgical operations, might be inferred when the action of these gasses was determined. With this consideration I have undertaken some experiments on the subject. I shall relate here the results which I have obtained, together with some additional attempts on the same matter. The facts which I have observed, appear to me to explain most of the particularities of the treatment of sulphuret of lead, and they shew clearly enough the principal cause of those differences which have been noticed in the quantities of the products which this mineral affords according to the methods adopted to extract the metal.

Before I describe the action of elastic fluids on the sulphuret of lead, it appears to me necessary to relate how it is effected by an intense heat in close vessels.

*Action*

*Action of Heat.*

If galena be exposed to a very strong heat in an earthen retort, connected with a bent glass tube terminating in water, so as to intercept the communication of the exterior air; there immediately appears a faint smell of sulphureous acid, the formation of which may be attributed to the atmospherical air contained in the retort; shortly after, the interior of the glass tube is covered with drops of sulphur; the sulphur as it evaporates appears to carry over a little sulphuret of lead, which is deposited in fine powder. If when the quantity of sublimed sulphur no longer sensibly increases, the heat is stopped and the retort broken, the principal part of the sulphuret of lead is found in the neck, a portion in small crystals, the rest in a compact mass, very fragile and of a very brilliant fracture, consequently it has suffered no change in its composition. The fixed residuum appears to have been in perfect fusion; its fracture is still brilliant and lamellar, but it possesses already a little ductility, and it will admit of being cut with a knife; on the application of a low heat, lead in its metallic state separates from this substance. It is in fact a sub-sulphuret, analogous to that which is known in the foundries under the name of *matte de plomb* *.

Thus by heat alone galena suffers a commencement of decomposition, one portion of the sulphur is separated, the residue is a sub-sulphuret, and the principal part of the galena is sublimed; but this sublimation requires a very intense heat, and so far it appears to me

* M. Guenyveau has obtained a similar result (vide Journal de Mines, tom. 21. p. 9); but as he employed a black-lead crucible, the change produced on the galena might be attributed to the presence of carbon.

very different from that which took place in the subsequent experiments, in which galena was exposed to the action of a current of gas. Of these experiments I proceed to give an account.

*Action of Gases on Sulphuret of Lead.*

The apparatus which I employed consisted of a porcelain tube, into which I introduced a known weight of galena in small pieces. This tube traversed a furnace, so that the two ends might extend from six to eight centimetres each beyond the exterior side. I adapted to one of the extremities a tube of bent glass, which was plunged some millimetres into water. By the other extremity I introduced the gas, the effects of which I intended to ascertain; and I always took care when it was possible, to admit at once sufficient gas to expel the atmospheric air in the apparatus. I then raised the fire, and when the tube was at a cherry-red heat, I transmitted the current of gas more or less quickly.

*Action of Sulphureous Acid Gas and Carbonic Acid Gas.*

I bring under one head the experiments made with these two different acids, because they appear to me to have effected no alteration in the composition of the galena *.

The effect of these gases is limited to the carrying over a considerable quantity of this substance which immediately covers the interior of the glass tube; the remainder of it is deposited in an impalpable powder in

* There remained a very small button of ductile lead after operating upon galena with carbonic acid; but as a little sulphureous acid was formed, and dissolved by the water which received the glass tube, the decomposition of the sulphuret might be owing to the presence of a little atmospherical air.

the

the water, in the midst of which the extremity of this tube is plunged.

When the sulphureous acid is slowly disengaged, the sulphuret of lead remains in the porcelain tube; but then I found the part of the tube which exceeded the furnace, filled with very brittle crystals of sulphuret of lead, some of which were even three millimetres in diameter. The formation alone of these crystals proves, that the action of the gas of the sulphuret of lead is not entirely mechanical, since the latter substance is carried over in vapours which condense when cold, and form regular bodies if the disengagement of the gas is sufficiently slow.

*Action of the Vapour of Water.*

The effects of steam in respect to the volatilization of galena are analogous to those just described. It draws the sulphuret over in a large quantity; but the residue presents independent of what is unchanged, metallic lead, and oxyd of lead; hydrogen, and sulphuretted hydrogen, may be collected during the operation.

These results may originate from many causes, it is difficult to point out the true one; but it is proper to remark that steam, like the other gasses, determines the vaporation of the sulphuret of lead.

*Action of Hydrogen.*

Hydrogen, when the current is rapid, carries over a portion of sulphuret of lead like the other gases, but the principal part is found reduced to the state of ductile lead by the subtraction of sulphur, which enters into union with the hydrogen, and forms sulphuretted hydrogen.

drogen *. It is, moreover, remarkable, that the lead should be at a particular temperature to effect this decomposition; for the galena was only converted into pure lead in that part of the porcelain tube within the furnace †; the exterior part was lined only with sulphuret of lead.

*Action of Atmospheric Air.*

M. Guenyveau has shewn that sulphuret of lead, by the slow action of air and heat, may be converted almost entirely into a sulphate; but if the air, instead of being allowed to act slowly, is sent in a rapid current

* M. Klaproth, in distilling the hepatic ore of mercury from Idria, obtained a similar effect, which he attributes to the action of charcoal, either upon the small quantity of oxygen that may be combined with the mercury, or upon the sulphur with which it may form a carburet of sulphur. Journal des Mines, tom. 19, p. 320.

† This decomposition indicates the origin of the odour of sulphuretted hydrogen which roasted galena emits when operated upon in the open air, by means of wood or of moist charcoal; and it proves that the smell does not shew a mixture of pyrites. It is not, indeed, pure hydrogen that is disengaged in these circumstances: but the Dutch chemists have proved, that the hydro-carburets have the property of forming sulphuretted hydrogen (the carbon being precipitated) by contact with sulphur at a high temperature. It appears even that this effect takes place more readily with hydro-carburet than with pure hydrogen, since sulphuretted hydrogen cannot be obtained with the last gas. (Vide Thomson, vol. I. p. 99.) This I presume depends on the degree of heat employed; for M. Gengembre, as they themselves observe, (Journal de Physique, tom. 40, p. 414,) had another result in fusing sulphur in a bell full of hydrogen by the rays of the sun collected in the focus of a burning glass; and I too have obtained sulphuretted hydrogen by transmitting hydrogen over sulphur fused in a porcelain tube. I recollect, I think, to have seen M. Vauquelin make the same experiment with a similar result, (it is about fifteen years since,) in a lesson to the Polytechnic School.

upon

upon the galena heated to redness, a white dense cloud, having a strong smell of sulphureous acid, is seen to arise from that part of the tube where the current enters; the vapour deposits on the bodies it touches a white and fine powder, which is nothing more than sulphate of lead, mixed, perhaps, with a little sulphite. It is the same substance as composes those torrents of white smoke which issue from the furnaces where lead is heated, the nature of which M. Proust, I believe, first made known *.

After a certain time these fumes almost entirely cease; and if the substance remaining in the tube is examined, it is found to be pure lead. The quantity of lead extracted is equal to nearly half the weight of the galena submitted to the experiment.

If, in this instance, the matter drawn over by the current of gas is not of the same nature as that which was sublimed in the preceding operations, it is owing evidently to the action exercised by the oxygen in the molecules of sulphuret of lead as soon as they are separated from the solid mass, exposed at the same instant to heat and oxygen, they ought to be immediately converted into a sulphate. It appeared to me probable that the nitrogen and sulphureous acid gas which is formed, both, favour the volatilisation of the galena; yet oxygen alone produced a similar effect; a circumstance that affords new proof that sulphuret of lead rises in vapours at a comparatively low heat. These vapours are converted into sulphate, or are carried over in the state of sulphuret, according as they are in contact or not with the oxygen: thus there is no doubt, but that all the galena which sublimed in the preceding experiments would

* Journal de Physique, tom. 50, p. 395.

have

have been converted into sulphate if it had come in contact with oxygen at the moment it rose in vapour. This is confirmed by the following experiment.

*Action of a Mixture of Atmospheric Air and Sulphureous Acid Gas.*

If instead of atmospheric air alone, a current is employed composed of atmospheric air and sulphureous acid, results are obtained similar to those of the preceding experiment, with this difference indeed, that a proportionably smaller quantity of metallic lead remains in the tube. Here the sulphureous acid mixed with common air produces a copious volatilisation of the galena, which is immediately converted into sulphate of lead.

After the observations already made, it may, I think, be established as a certain fact, that the sublimation of sulphuret of lead is singularly favoured by a current of any gas that can act by means of its chemical properties. This effect, which depends on the faculty that galena presents for rising in vapour in close vessels, is a new proof of the general occurrence of that phenomenon, towards which M. Gay-Lussac, in his Memoir on the Vaporation of Bodies *, has first called the attention of chemists, and is at the same time one of the most striking examples of the kind that can be cited.

Lead, as it may be concluded from the experiments already described, does not sublime with nearly the same facility.

Sulphate of lead does not appear to suffer any action of this kind from the gases to which it is exposed. Some only act on it chemically: thus hydrogen, at a pretty

* Memoirs d'Arcueil, tom. 1, p. 294.

low

low temperature, reduces it to a sulphuret, and then it is effected as described above.

If we now reflect on the faculty which gases have of aiding the vaporation of galena, it will be easy to conceive what a loss must be produced by their action in the treatment of this ore, and how, consequently, it is disadvantageous to separate the sulphur in the state of sulphureous acid. Besides, all the processes in which this gas is disengaged must occasion great waste. In the reverberatory furnace, for instance, in which the sulphuret of lead is roasted, and where sulphureous acid is produced, either by the direct action of atmospheric air upon the sulphur, or by the re-action of part of the sulphate upon the sulphuret *, the chimnies are choaked up in a short time, and are found full of sulphate of lead, which is only a small portion of the quantity which is disengaged in fumes.

In the blast furnace the loss should be, and indeed is, much more considerable; for it is evident, that the heat being more intense, the wind of the bellows ought to act not only on the sulphuret but on the lead itself; so that in some founderies, where this kind of furnace is employed to fuse the roasted ore, thousands of quintals of lead are dispersed each year in the atmosphere. It

* This re-action which M. Guenyveau has made known, (Journal des Mines, tom. 21, p. 16, &c.) is produced, he thinks, according to the proportions employed; a mixture of oxyd and sulphate, or of oxyd and sulphuret; but the last result is not obtained with the proportions he has mentioned if the heat is very intense. With a low degree of heat I have witnessed the results which he has announced; but with a higher I have obtained ductile lead. When the heat is not sufficiently strong to decompose the galena, this substance presents itself in a well-fused mass, and its surface offers a multitude of little cubes, salient and perfectly regular.

is

is possible that the scoria which it is usual to mix with the roasted ore, may oppose in some measure this effect, which it is necessary to distinguish from the purely mechanical effect of the wind of the bellows. But in this case if the sulphate of lead is abundant as it inevitably must be, or if the ore is ill roasted, that is to say, if there remains much sulphur, the furnaces will afford a large quantity of subsulphuret, which will suffer a new loss from the necessary operation of a second roasting.

From what has been said, it may be concluded that the most profitable way of treating the sulphureous ores of lead, is to decompose them by a substance which will absorb the sulphur without giving rise to any gaseous products. Iron is employed in many instances for this purpose, and I think it is the best intermedium that can be applied; but even in this case it is of importance to prevent the blast of the bellows from coming in contact with the mixture, before the decomposition is effected. The scorias which are added, are not of the same inconvenience as in the process in which the ore is fused without iron, since the last metal absorbs sulphur even in the midst of the fused mixture. Nevertheless, it is impossible that all the galena can be defended from the current of air; and in this case there will be notable loss, if a judgment may be formed from the results of the following experiments.

If in a retort similarly disposed to that in which galena alone was submitted to a high temperature, a mixture of ten parts of sulphuret of lead, and three parts of iron filings, be heated, slight traces only of sublimed galena are observed, provided the retort bears the impression of the fire; but if it cracks, copious black fumes of sulphuret of lead are disengaged, the sulphuret

is

is not converted into sulphate, because the extremity of the tube is too cold to produce that effect *.

To avoid the like inconvenience, it is necessary that the mixture of iron and galena should be exposed to heat, without being struck by a current of air. A reverberatory furnace appears to me best adapted to answer this end. It will be sufficient to cover the mixture of iron and galena with a slight layer of easily vitrifiable matter. Then no loss scarcely is to be feared.

Unfortunately iron in most places is at too high a price to be employed in this operation. I do not know that it is possible with complete success to replace it by its oxyds; for the disengagement of sulphureous acid will necessarily occasion a great loss. By adding to the mixture a certain portion of powdered charcoal, much galena will be carried over by the carbonic acid thus produced. There is a probability of avoiding these inconveniences, and of employing to advantage a rich oxyd of iron. It will be sufficient to reduce the iron to its metallic state by a preliminary operation. This operation consists in breaking the ore into small fragments, in mixing them with charcoal powder, and in heating the mixture merely at a red heat for some hours. It is known that iron in this may way be brought into a ductile state. I do not know how far this operation may be executed, and I propose it only with a great deal of diffidence; nevertheless, it appears to me worthy of having some trials made to ascertain the possibility of putting it into practice.

* A similar result is obtained when the galena is alone? if the retort break the sulphuret of lead entirely evaporates, and if it be stopt before the whole is sublimed, the portion that remains is hard and fragile, and it appears to have suffered no partial decomposition.

*Observations on the Proportions of Elements in some Compounds.* *By* M. C. L. BERTHOLLET.

From the MEMOIRES D'ARCUEIL.

I ENDEAVOURED in the last part of my researches on the laws of affinity (Mem. de l'Insit. 1806), to determine the comparative capacity of saturation of different acids, relative to alkaline bases; and to effect this purpose, I attempted to establish by my own experiments, what were the proportions of the constituent parts of most of the neutral compounds; but I have perceived in my experiments causes of error which I did not suspect: the object of this memoir is to rectify them.

One of the most important determinations is, that of the proportions of sulphuric acid and barytes in sulphate of barytes, because it is frequently employed in analyses to make other estimations: on a slight consideration, nothing appears more easy than to fix the proportions. Yet the proportions of sulphuric acid given by different chemists, well known for their accuracy, vary from 0.24 to 0.34.

The method which I pursued consisted in distilling to dryness in a retort, a determined quantity of the solution of very pure barytes, and in exposing the residue, collected with great care, to a forge heat in a platina crucible. I ascertained by that means the quantity of barytes that was in the solution; so that nothing more was necessary to be done, than to determine the quantity of the same water of barytes that would neutralize any acid, to compare its capacity of saturation; for that was proportionable to the quantity of water of barytes necessary to bring equal weights of the acids, to the neutral state.

M. Thenard

M. Thenard has employed, to determine the composition of sulphate of barytes, a method which appeared to me to leave no doubts concerning the results which I obtained, if a slight compensation were made for the loss which could not be avoided in my process. He employed crystals of barytes which had been heated in a platina crucible till they liquified; he saturated the barytes with sulphuric acid, and exposed the sulphate of barytes thus formed to a strong heat, in a platina crucible also. The proportions of sulphuric acid and barytes, which enter into the composition of sulphate of barytes were according to this experiment,

74.82 barytes,
25.18 sulphuric acid,

100.00

I conceived in taking the mean term between the results of my experiments and those of Thenard, that one might consider as a great approximation the proportion of

0.74 barytes,
0.26 sulphuric acid,

100.00

And I have established in this datum the proportion of sulphuric acid, both in common sulphuric acid and in many salts. In the mean time, M. Rose published the details of three experiments; the results of which differed materially from ours. According to the first, 100 parts of sulphate of barytes are composed of

69.09 barytes,
30.91 sulphuric acid,

100.00

which almost exactly coincides, as he has observed, with the first determination of Bucholz, and with that of Richter. According to the second, they are composed of

67.56 barytes,
32.44 acid,

100.00

which agrees with the second determination of Bucholz. And, according to the third, they are composed of

69.77 barytes,
30.23 acid,

100.00

On the other hand, M. Berthier, distinguished for the care he takes in his analyses, found the proportions very near to those of Rose: he made the proportion of barytes 67, and that of sulphuric acid 33.

M. Thenard and I repeated our experiments; and many essays gave us results very similar to those which we had before obtained.

We were at a loss for the cause of this difference, when M. Descostils brought to Arcueil the same barytes that M. Berthier had employed. It gave us for the sulphate very nearly the same proportions which he himself had obtained.

It was then proved, that the difference between the results depended on the barytes itself. That which Thenard and I employed, and which we regarded as absolutely barytes, came from barytes that had been crystallised, and was strongly heated. That of Berthier was procured from nitrate of barytes, according to the process which we owe to Vauquelin. Both appeared equally pure from the experiments we made on them; nevertheless,

theless, they presented remarkable differences in their properties.

That which was obtained from crystallised barytes liquified more easily than the other in a platina crucible; it acquired, on cooling, the appearance of a semi-transparent glass; it dissolved very slowly in muriatic acid; and it afforded only very slight traces of carbonic acid.

The other barytes not only required a far stronger heat to render it liquid, but after being a long time in the fire it lost instead of gained weight, and it then quickly dissolved in acids with a brisk effervescence; in fact, it had combined whilst in the platina crucible with carbonic acid, which had entered under the cover of the vessel.

The first barytes presented all the characters of a compound; it is united with a substance that diminishes its action with other bodies, that renders it more fusible, and that gives it by fusion the appearance of a glass. This substance could be water alone; and, indeed, when a little water was added to the second barytes, it received, by exposure to fire, all the properties of the first.

I confirmed the existence of water in the first barytes by heating it with iron turnings in a porcelain retort; a large quantity of hydrogen gas was disengaged; but of this I shall speak in its proper place.

Thus we see, on what depends the difference between the results which Thenard and I obtained and those of most other chemists; yet, it might be imagined, that the water which is combined with the barytes, and which gives it the peculiar properties just described, might be driven off by the long-continued action of a strong

strong heat; for Rose likewise used crystallised barytes, but he exposed it to a red heat for many hours in a retort surrounded by burning coals, with the very delicate precautions which he describes. He avoided in his process the communication of carbonic acid; which could not be easily done in a platina crucible placed in the midst of charcoal: but it is probable that, in the long action of a strong heat, part of the retort acted on the barytes, and occasioned by that means the dissipation of the water; in fact, that this water, which made a part of our estimation, was excluded from that of Rose. Nevertheless, it appears, that in the first of the three experiments which he describes, as well as in that of Richter, and in the first determination of Bucholz, the barytes should have contained a small portion of water.

The experiments which Thenard and I have made, employing barytes obtained from the nitrate, and the results of which I think it right to adopt, make the composition of sulphate of barytes very nearly agree with the two last estimations of Rose, and almost exactly with the determination of Bucholz: the result which appears to me to approach nearest the truth gives the proportions of

67.70 barytes,
32.30 acid,

100.00

which, it may be perceived, does not differ more than a fraction from the proportions determined by Berthier, who assigns to sulphate of barytes, 67 of barytes and 33 of acid.

In applying these proportions to the experiments which I have described upon the proportion of water contained in sulphuric acid of a determined specific gravity,

gravity, and upon the proportion of oxygen which combines with the sulphur to form this acid—

1°. 100 parts of sulphuric acid of the specific gravity of 141.70 contain 38.58 real acid; and according to Kirwan they contain 42.67.

2°. 17 gram. .346 of sulphur converted into sulphuric acid by means of nitric acid, have given me 127 gr. 515 of sulphate of barytes: it follows that 100 parts of sulphur form 230.79 of sulphuric acid; and consequently that 100 parts of sulphur combine with 130.79 of oxygen. A similar experiment made by Klaproth would give, applying the same means of valuation, 130.68 of oxygen for 100 of sulphur. This coincidence is the more readily to be confided in, as a like experiment of M. Thenard gives nearly the same results.

After I had satisfied myself that barytes retains water so powerfully, I suspected that potash might retain it also, and likewise that it should exert a more violent action upon this liquid; but before entering upon any experiments to ascertain this, I sought the reason of the difference between my results and those of Thenard upon the proportions of potash and muriatic acid, in the muriate of potash. I had fixed these proportions at

26.60 muriatic acid.
100.00 pure potash.

126.60

And Thenard had found 30 of muriatic acid with 100 of potash. I shall not enter into a detail of the experiments which we made together to discover the cause of this difference; I shall only remark, that it was principally owing to the action of the potash on the platina crucible, of which a notable quantity is dissolved if the alkali

alkali is kept long in fusion. A silver crucible is better adapted for this experiment, although it is itself slightly attacked. I then repeated the experiment, avoiding the sources of error which I had discovered. I kept the potash in fusion in a silver crucible, till the vapours which arose on uncovering the vessel ceased to appear. I then had in different essays, results which very nearly approached to the determination of Thenard.

To discover whether potash does not retain water which it abandons, when it enters into combination, I made an experiment, the details of which I think it right to give; first, observing that potash strongly attacks the platina crucible, and exercises a slight action on the silver one; whilst muriate of potash acts rather more strongly on the silver than it does on the platina crucible.

A silver crucible was dried perfectly, it weighed 187 gr. 491. Potash was fused in it, and kept in a liquid state till it exhaled white fumes on uncovering the crucible. When it was cooled sufficiently, it weighed 203 gr. .221: it contained therefore 15 gr. .730 of potash. The alkali was dissolved by muriatic acid and the solution was evaporated in a silver pan.

The salt was collected with great care, and the washings of the pan were evaporated in a platina crucible, to which the dry salt was added: the whole was exposed to the heat of a reverberatory furnace in a platina crucible imbedded in a clay crucible; the heat was continued till the muriate, being in fusion, appeared to give off slight fumes on uncovering the vessel.

The platina crucible weighed 117 gr. .635, with the cold muriate of potash, it weighed 137 gr. .970: it contained therefore 20 gr. .335 of muriate of potash.

These

These 20 gr. .355 of muriate of potash gave 38 gr. .586 of muriate of silver well dried in a porcelain capsule. Now 100 of muriate of silver contain 17.50 of muriatic acid according to the valuation of Bucholz, which scarcely differs from that of Rose, and which is almost the mean between the estimations of M. Chenevix, Zaboada, and Proust: the 38 gr. .586 of course contain 6 gr. .732 of muriatic acid; from which a deduction of 20 gr. .730 being made, no more than 13 gr. .558 remains for the weight of the potash; it must then be admitted that 100 parts of potash kept some time in fusion, retain 13.64 * of water, which may be driven off by heat from the compound that was formed.

I confirmed the existence of water in potash, by putting some dry potash into a porcelain retort, heating it in a good fire till white vapours were seen to arise, then adding iron filings, and luting to it a tube connected with a pneumatic apparatus; the fire being suddenly raised, and many precautions taken for excluding watery vapour, a large quantity of hydrogen gas was pretty rapidly produced.

It appeared to me that potash first abandons only that part of the water which it retains with least force, and that when it is deprived of this liquid to a certain degree, the next effect of the fire is, the evaporation of the alkali itself with the remaining water; this is the origin of the white fumes just said to exhale at this period: in this respect potash may be compared with sulphuric acid and many other substances, which at first

* An experiment has since been made, from which it results that 100 of fused potash contain 13.89 of water. The difference being so small, it was thought useless to make any alterations in the calculation.

relinquish a part of the water of combination, but which afterwards rises with it, when the affinity which formed the combination no longer permits the separation.

In comparing the experiment which I have just described with some others, I regard the following determination as the greatest approximation: 100 parts of potash kept in fusion till vapours begin to appear, require 29.5 of real muriatic acid; but they contain 13.64 of water which may be expelled from the compound: consequently 86.36 of potash must be substituted for 100, and 43.14 of acid instead of 29.5; according to which, 100 of real potash require for their saturation 49.95 or 50 of muriatic acid, and 100 of muriate of potash is composed of

| | |
|---|---|
| 66.66 | potash, |
| 33.34 | acid, |
| 100.00 | |

This water, the existence of which I did not formerly suspect, conduced to the erroneous results which I proceed to rectify.

1°. I had supposed that muriatic acid of the specific gravity of 10.614, which I had formed by impregnating distilled water with muriatic gas that had been long exposed to 13° of the centigrade thermometer below the freezing point, and in which 12.467 of the acid gas were condensed by 100 of water, owed at least half the weight of the gas to water that remained in combination with it, in spite of the very low temperature to which it had been exposed, because 100 parts of potash had required for their saturation 61.5 of this acid, and according to calculation, I only obtained 126.60 of muriate of potash.

It

It was first necessary to correct the last number, and to raise it to 129.5; it was requisite afterwards to subtract the water that the potash contained; and then the number for 100 parts of real potash is brought to 170.63: from whence it follows, that water which has absorbed 12.467 of muriatic gas contains no more than 8.82 of real acid.

I made another experiment to confirm this result. I took 70 gr. .573 of muriatic acid, of the specific gravity of 10.614, and precipitated by nitrate of silver; the muriate formed weighed, when dried on a sand-bath in a porcelain capsule, 94 gr. .44, which would give, allowing 100 of muriate of silver, 17.50 of acid, for 100 parts of this acid 8.55 of real acid. These two numbers sufficiently coincide to confirm each other, and likewise to prove that the quantity of water which I have attributed to potash ought to approach the true estimation; yet the number indicated by the second experiment, should be regarded as most exact, and it results from it that muriatic gas which has been considered as free from hygrometrical water, retains in combination about 12.467, 3.917, or a third nearly of its weight.

2°. I have observed, that 100 parts of muriatic acid, of the specific gravity of 10.614, contain, according to Kirwan, 8.04 of real acid; and it appears from my last experiment, that they should contain 8.55; 100 parts of potash, independent of water, require to become neutral 50 of muriatic acid, and according to Kirwan 56.3. It appears then, that, avoiding the cause of error which the water occasions, my result coincide very nearly with his.

The water which potash contains ought not only to influence the valuations of which I have spoken, but to

occasion an error in all estimations in which potash is considered pure. It is the principal cause of the different proportions which have been admitted in the elements of nitrate of potash. I have found that 100 parts of potash require for their saturation 70.31 of nitric acid, abstracting all the water of crystallisation, which makes the composition of 100 of dried nitrate of potash.

58.71 potash,
41.29 acid,
100.00.

M. Thenard has found, following the same method, that 100 of nitre previously fused, are composed of

59.5 potash,
40.5 nitric acid,
100.0

TO BE CONCLUDED IN OUR NEXT.

*Examination*

## *Examination of some Iron Ores, and Products of the Smelting-houses.*

*By* M. GUENYVEAU, *Mine Engineer.*

(Concluded from Page 244.)

### I. *Scoriæ which run out when the Smelting goes on well.*

THESE Scoriæ are white or greyish, sometimes of a very deep green; they are usually opake, particularly when they are white. The specimen analysed was a mixture of white and grey parts.

M. Bouesnel found in it,

| | |
|---|---|
| Silica | 49.6 |
| Lime | 30. |
| Alumine | 15. |
| Red oxyd of iron | 3. |
| Manganese, none | |
| Chrome, none | |
| | 97.6 |

It is to be supposed that all the scoriæ formed when the smelting does not suffer any derangement, are composed of the same principles, and nearly the same proportions; it may even be conjectured that these proportions are the most favourable for the smelting of the iron ores which are employed, because all the trials made with the furnace at work, are made with this intent.

On comparing the result of the preceding analysis with that of an analysis which was made of scoriæ formed in the furnace at Geisslautern, when the fusion went on well, it may be concluded that there really exists certain proportions in which these earths ought to be mixed

in

in a furnace, in order that the smelting of the iron ore should be executed with œconomy and success.

Scoriæ of the furnace of Geislautern, being a rather transparent glass.

| | |
|---|---|
| Silica | 49. |
| Lime | 30. |
| Alumine | 15. |
| Red oxyd of iron | 3. |
| Oxyd of manganese | 1. |
| Some trace of copper | |
| | 98. |

The coincidence is so great, that it might perhaps be attributed to chance; but it is also so remarkable, that it is impossible not to believe that the proportion of the earthy principles which has been determined by experiments made at one of the smelting houses, does not approach very nigh to those which have been observed in the other *. However, a great number of analogous facts would be required, in order to give this conjecture all the force which its importance requires.

II. *Scoriæ of the High Furnace at Creusot, when the Fusion does not go on well.*

These scoriæ are badly vitrified, very porous, almost black: they do not contain any iron shot, and are not the worst that are run out of the furnace. When these scoriæ are thick, and the furnace is choked, the pig-iron is white, and much less fluid than is commonly the case.

* The ores smelted at Geislautern are argillaceous iron ores, to which limestone (castine) is added.

There

There was found in them,

| | |
|---|---|
| Silica | 39.5 |
| Lime | 35.6 |
| Alumine | 18. |
| Red oxyd of iron | 3. |
| Some trace of manganese | |
| | 96.1 |

Although the constituent parts of this kind of scoriæ are the same as those of the preceding, the proportion of them is sensibly different; and it must be particularly noticed that the silica is in less quantity, while the proportion of the other two earths is greater than before.

The causes that tend to derange the regular course of smelting are numerous, and it is frequently difficult to discover which of them have the greatest influence: a diminution in the quantity of air furnished by the blowing machines, a variation in the fuel, and especially in the earthy admixtures, is sufficient to render the scoriæ thick, and to choke the furnace, whatever is the cause that produces the derangement of the process of smelting; whether it be the diminution of the temperature, or of the fusibility of the mixture, the smelters always endeavour to form a more fusible mixture than that on which they are operating; and the most usual remedy is to add some earthy substance, or some particular kind of ore which has been found by experience to facilitate the fusion of the ore. At Creusot, the Chalancey ore contains a great quantity of lime, and the smelters mix it, in a certain proportion, with that from Riminy, which contains a good deal of silica and alumine *, so as to

* The proportion of alumine found in the ores does not in the least answer to that contained in the scoriæ; it is to be supposed that riminy ore usually contains more of that earth than there was in the specimen which was analysed.

form

form a mixture that is fusible at the ordinary temperature of the furnace: it appears that the addition of silica is an indispensable condition, and when the proportion of that earth is diminished, the fluidity of the scoriæ is diminished, as is shewn by the analysis of No. 2. When the composition of these ores is known, it is easy to comprehend how the use of a kind of coak which contains a considerable proportion of earthy matter (such as No. 2.), and particularly of lime and alumine, must be hurtful in smelting on account of its diminishing the fusibility of the mixture by the superabundance of these earths.

When the high furnace at Creusot is embarrassed, it not only happens that the scoriæ become thick, but the twyer (which is made of clay) is also corroded, and burned: at first it appears difficult to explain this phenomenon; but by reflecting on the action which the substances contained in the furnace must necessarily exert upon the walls thereof, it will be perceived that these substances will vitrify with the earths that compose the walls, by exercising some attraction upon them; but this will not take place when the proportion of the earthy elements in the scoriæ is such that they reciprocally saturate each other at the temperature of the furnace. This conjecture will be converted into a certainty, by observing that the fluidity of the scoriæ is restored, by augmenting the proportion of *cold ore*, which contains 60 *per cent.* of silica, and that then the twyer, the clay of which contains also 80 *per cent.* of the same earth, does not suffer any alteration. It is evident, that scoriæ, which are of difficult fusion on account of the silica being in too small a proportion, endeavours to combine with that earth, and destroys the walls of the furnace

nace in which they are contained; but when the scoriæ are saturated with silica, at the temperature of the furnace, the walls are no longer damaged by them. It is therefore an essential condition in every mixture of earths introduced into a furnace, that it should exercise little or no action upon the substances that compose its walls: now, it is very easy to fulfil this condition after some trials; and it may be seen that those ores which are rejected by some iron-masters because they destroy the furnace, might be employed, either by changing the substance of the walls, or by endeavouring to find out a convenient proportion of the earths which are to form the scoriæ. It follows, therefore, from these facts, that the choice of the materials with which it is intended to construct the walls of furnaces, depend partly upon the nature of the ores; and that it is not sufficient for the materials to be merely infusible without addition. In some works, limestone is used for building furnaces; but it is not to be supposed that it can be adopted for the smelting of all kinds of ores, as for example, for those that are very argillaceous, unless with great precaution. In general, such materials ought to be chosen, that, when the smelting is deranged, the scoriæ may not be rendered more fluid by dissolving the walls of the furnace.

All these observations tend to prove, that the art of smelting iron ores in high furnaces consists only in finding out such earthy mixtures as will form, at the temperature to which they are exposed, scoriæ possessed of sufficient fluidity, and that do not attack the walls of the furnace; in keeping up the heat constantly to the same degree; and lastly, in knowing how to re-

medy the accidents resulting from unavoidable variations in the composition of the ores and fuel employed.

### III. *Pig Iron.*

The analysis of the pig-iron produced in these furnaces, which is very remarkable for its bad quality, yields some interesting results; and a great number of experiments having been made, no doubt is left in respect to the proportion of its ingredients, unless it be that of the charcoal, which it is always very difficult to appreciate exactly.

The grain of the pig-iron is grey, in very small grains, and rather dull; it is very brittle, and may be reduced to powder: it is soft to the file, and fills up the moulds well.

The component parts, *per cent.* are,

| | |
|---|---|
| Silica | 3,5 |
| Alumine | 0.8 |
| Lime | 0.5 |
| Sulphur | 0.3 |
| Phosphorus | 0.75* |
| Charcoal | 2.1 |
| Some traces of manganese | |
| No chrome | |
| Metallic iron | 93.15 |
| | 100. (is 101.1) |

The great quantity of phosphorus contained in this pig-iron, is fully sufficient to explain its brittleness, and there is no occasion to suppose that the sulphur

* In the first trial, 0.4 grammes of phosphate of lime was obtained from 10 gr. of pig-iron; in the second, 0.38 gr.; the mean of these experiments is 0.39 gr. which contains, according to M. Berthier 0,75 of phosphorus.

it

it contains has any great effect in this respect; but it is not the same with the earthy substances which it contains in a rather large proportion, and it is to be supposed that they render the pig-iron brittle. Nevertheless, this alone can scarcely be the cause of its being unfit for making cannons, because all these substances ought to be easily separated from the pig-iron at the time when it is re-melted in the reverberatory furnace.

The director of the foundery at Creusot is probably right in supposing, that the bad quality of this iron, that is to say, the want of tenacity, which hinders it from being employed to make cannons, proceeds solely from the nature of the ore, and by no means from the process of smelting, or the fuel employed. The granular iron ore of Franche Comté (which yields very good pig-iron, when it is smelted with charcoal) was treated with coak, and the iron obtained from it was used for the making of a cannon which was subjected to every kind of proof: it resisted them all perfectly; and the founders were convinced that, by smelting a good kind of iron ore with coak, pig-iron proper for making all sorts of cast work might be obtained. Notwithstanding this trial, cannon have never yet been made with pig-iron smelted with coak: the only iron employed has been that of Franche-Comté, or the pig-iron from the ore of that country smelted with charcoal at the foundery. As no specimen of this iron was found among those that were collected on the spot, it was not analysed; but the defect is in some measure supplied, by giving the constituent parts of a specimen of pig-iron that was sent to the board of mines by the inspectors of artillery, as being very proper for making cannons. It is not known from what

this specimen came, nor whether it had been re-melted in a reverberatory furnace.

This pig-iron is grey, and lamellar in its grain: it is malleable under the hammer, and seems very difficult to break; it is very soft to the file.

There was found in it,

| | |
|---|---|
| Silica | 0.54 per cent. |
| Some traces of alumine | |
| Phosphorus | 0.27* |
| No sulphur | |
| Charcoal | 2.4 |
| A little chrome | |
| Metallic iron | 96.79 |
| | 100. |

It is surprising that so much phosphorus should be found in a specimen of pig-iron which was recommended as being very proper for making cannons. Whence it must be inferred that this proportion, although it has certainly some influence on the quality of the iron, is, however, too small to render the iron brittle. An attempt was made to estimate the quantity of the chrome that was contained in it, as it was supposed at first that it might be estimated with some precision; but after several experiments, it was found that the chrome did not form at the utmost one thousandth part of the mass.

* In the first experiment, 10 grammes of the iron yielded 0.11 gr. of phosphate of lime, another experiment yielded 0.23 gr. from 15 gr. The mean, 0.13 gr. indicates 0,027 gr. of phosphorus.

*Extract*

*Extract from the Memoir of Messrs.* MOUCHEL, *of l'Aigle, in the Department de l'Orne, on the Manufacture of Iron and Steel Wire.*

With a Plate.

THE manufactory of Messrs. Mouchel, situated at l'Aigle, in the department de l'Orne, is one of the most considerable in France: it furnishes annually, in cards for wool-combing only, an hundred thousand quintals of iron-wire; a part of which is consumed in the departments, and the rest is exported to Portugal, Spain, Italy, and even to the shores of the Levant. The vicinity of Paris, Rouen, and the sea-ports, afford a certain market for its productions.

The attention of the manufacturer must in the first instance be directed to the choice of the primitive material. Accordingly, Messrs. Mouchel have endeavoured to procure iron of the best quality, and there are few smelters whose specimens have not been submitted to their researches. They adopted that of the departments of l'Orne and la Haute Saone as being of the best quality.

The first produced the best wire for screws, nails, and pins, as much on account of its hardness, as its fine polish, which resembles steel wire, and in this respect is superior to the iron of *Haute Saone*. But from its ductility, the latter can now be made extremely fine, and it appears to be most free from heterogeneous particles. However, the other may be rendered much like it by certain modifications in the extraction and choice of the ore.

Messrs.

Messrs. Mouchel employed in their works, the iron from both of the above-mentioned departments; that of *Haute Saone* gave satisfactory results, although it also presented difficulties. They were under the necessity of supplying themselves from various iron-makers who frequently furnished them with iron of different qualities; which proved extremely prejudicial to the uniformity and perfection required in the delicate processes that are necessary in making iron wire. This obstacle, and persuasion that it was possible to obtain the wires till more pure, induced the authors to establish a smelting-house of their own.

They accordingly procured one situated in the department of *Haute Saone* near the best furnaces, and confided the management of it to an able smelter.

The smelted iron, prepared and hammered, being in a state nearly fit for their purpose, is transported at a small expense to *l'Aigle* by the rivers and canals.

When the iron is formed into an irregular bar, of about a *centimetre* in *diameter*, they begin to draw it into wire. Although it be already much extended by hammering, it is in the first place passed four times through the drawing plate; then its molecules, disposed lengthways, exhibit fibres at their utmost extention, the fibres are removed by means of heat which dispenses and divides them; and after that, the wire may again be reduced three numbers; the fibres which are re-produced by this operation are again removed by heat; the whole process is five times repeated; consequently the wire is passed through fifteen numbers, after which a single exposure to the fire is sufficient to fit it for passing six others, and then it is reduced to the thickness of a knitting needle. The steel wire being much harder, requires to

be

be passed through forty-four numbers, and to be annealed every other time.

Thus far the wire is drawn with pincers or the tobbin; which latter is the invention of the grandfather of Messrs. Mouchel; it is a cylinder adapted to the axle-tree, and is used to avoid the marks made by the pincers.

The heat required for the wire must be regulated by its diameter, according to which the caloric penetrates more or less rapidly to the centre. Besides, when it is sufficiently stretched, each thickness exhibits a peculiar colour which the workman is careful to observe.

If the heat be not sufficient, the change of the mechanical state of the molecules will not be effected; that is to say, they will preserve the same situation and appearance as they have after being passed for the first time through the drawing plate; they will be stretched to the utmost extreme; their aggregation will be destroyed, in bringing the wire to the usual thinness: it will break every instant, and it will not afterwards be possible to restore its pliancy by the means of heat, because the dispersed particles cannot be influenced by it.

The contrary cause will produce the same ill consequences; for if the heat be too powerful, the molecules will be too much disunited to resist the tension they must necessarily undergo in the course of drawing the wire, which will therefore be constantly breaking.

In order to anneal the wire, Messrs. Mouchel have employed a large and elevated furnace; bars of cast-iron support the wire in the middle of the flames.

It contains seven thousand pounds weight, so contrived as to contain equal portions to each number. They are so arranged, that the thickest wires receive the strongest heat: therefore the whole is equally heated in the same

space

space of time. The operation lasts three hours, with a fire well kept up; and it might be imagined that this apparatus was completely adapted to the purpose; but Messrs. Mouchel have discovered several imperfections in it, because it leaves the wire exposed to the contact of the atmospheric air, the oxygen of which fastens on it with extreme avidity; whence a considerable loss of oxyd is occasioned, and also an expensive operation, to free it from the defect, which consists in beating the bundles of wire with a wooden hammer wetted with water. Notwithstanding this precaution, there often remains a portion of oxyd adhering to the surface of the metal: it streaks the drawing iron, fixes on the wire, gives it a tarnished appearance, and causes it to break when it is brought to a certain fineness.

The authors have long sought to remedy these inconveniences, and have at length invented another furnace (see Plate XVI.) It is round, and is about one metre six decimetres in diameter, and one metre eight decimetres in height, without including its parabolic arch and the chimney above it. The interior is divided by grates into three parts; the first, *b*, receives the cinders; the second, *c c*, is the fire-place; and the third space, into which they slide a rouleau of wire, weighing a hundred and fifty kilograms, which is inclosed in the space *g g* (comprised between two cast-iron cylinders); so that the flames circulate about the first *f f*, and within the interior of the second *e*, which defends the wire from the atmospheric air. The diameter of the largest cylinder is about one metre four decimetres; that of the second one metre; thus the space comprised between them is two decimetres, on an elevation of five decimetres. There must be several pairs of cylinders provided; because,

whilst

*Fig. 1.*

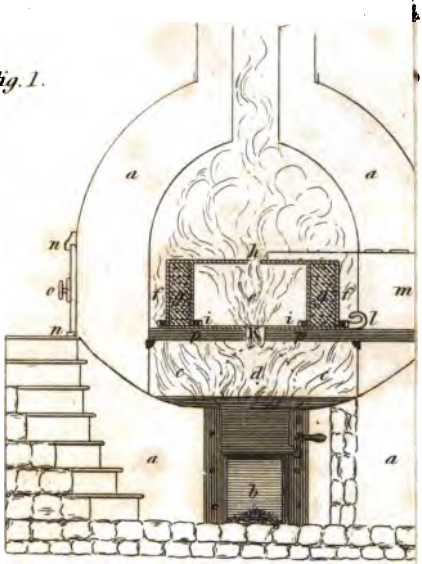
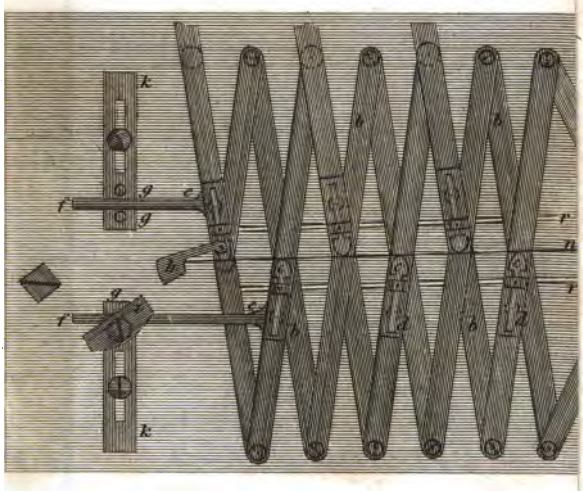
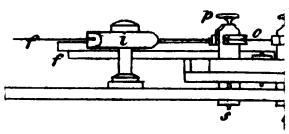



*Fig. 3.*



whilst one pair is in the furnace, another must be prepared to receive a fresh rouleau of wire. They are changed every hour by means of a long iron lever *u u*, with which a single man can easily push them in and draw them out again.

They are very careful not to open the cylinders immediately on their being drawn out of the fire; for the rouleaus of wire contained in them, being still red, would oxydate quite as much as if they had been heated in the midst of the flames without the least precaution.

The opening contrived for the passage is on the side, and has a door of cast-iron O, with a groove which winds round the furnace; the fire-place has one something similar to it; that of the ash-hole is vertical, in order that it may be raised to increase the fire at will.

## Explanation of the Plate.

Fig. 1, (Plate XVI.) *a a a a*, is a section of the furnace with its chimney; *b*, the ash-hole; *c c*, the fire-place; *d*, the door of the fire-place, placed opposite to that of the ash-hole; *e*, the interior of the small cylinder; *f f*, the external sides of the large cylinder; *g g*, the space between the two cylinders which contains the iron wire; *h*, the opening which facilitates the passage of the air and the flame; *i i i i*, the edges of the platform which are luted to prevent the admission of air between the two cylinders; *k*, the inner opening for the passage of the flame into the cylinder, and is larger than the upper orifice; *l*, a hook that serves to draw the cylinders out of the furnace, and forms a part of the platform; *m m*, section of the opening made for the admission of the cylinders; *n n n n*, circular grooves for the door of the said opening; *o*, section of the door;

*p p*, the grate that supports the platform; *q q*, the cast-iron surface on which the cylinder slides; *r*, the cylinder drawn out of the furnace; *s*, the chain with which it is drawn out; *t*, the capstan; *u u*, the lever; *v v*, teeth that support it.

Fig. 2, an horizontal view of the cylinders fixed to the platform.

This detail is sufficient to shew the advantages of this furnace. It is certainly more expensive to maintain than the other, but its advantages are more than an indemnification.

Messrs. Mouchel employ the lesser furnace for all the wire intended for cards, and they only use the larger one for steel wire or the iron from l'Orne, which is less liable to change; besides, being harder, it is not so easily attacked by the oxygen. In order to diminish the waste that the great furnace might occasion, they have contrived a new process, which consists in dipping the bundles of wire into a basin of wet clay, when they put them into the furnace, and there they are left to dry before the fire is lighted, without which precaution the clay will peel off before the iron is cool.

It is unnecessary to enter into further details with respect to the operation of annealing.

The authors use two sorts of drawing plates, large and small ones; the first for the sort of wire that we have been describing, and the latter for such as may be done by hand, and to which we shall presently attend. The steel which they employ for these drawing plates, should never vary in quality: except that such as are intended for the smaller plates are made the finest: as for the rest, the method of preparing them is the same as for other articles.

Several

Several pieces of iron are disposed in the furnace in the form of a box without a lid, their weight being according to the use they are intended to be employed in. The workman fills each of these boxes with cast-steel; having covered it over with a luting of clay, it is exposed to a fierce fire, until the steel be melted. His art consists in seizing the proper moment to withdraw the plate from the fire; he raises the luting and blows on it through a tube in order to drive off all heterogeneous parts, and then amalgamates it with the iron by light blows. After it is cool, he replaces it at the fire, where the fusion again takes place, but to a less degree than before; he afterwards works the steel with light blows of the hammer, to purify and solder it with the iron. This operation is repeated from seven to ten times, according to its quality, which renders it more or less difficult to manage. During this process a crust forms on the steel, which is detached from it the fifth time of its exposure to the fire, because this crust is composed of an oxydated steel of an inferior quality. It sometimes happens that two and even three of these crusts are formed of about two millemetres in diameter, which must also be removed.

After all these different fusions, the plate is beaten by a hammer wetted with water, and the proper length, breadth, and thickness is given to it.

When thus prepared, the plates are heated again in order to be pierced with holes by punches of a conical form; the operation is repeated five or six times, and the punches used each time are progressively smaller. It is of importance that the plate never be heated beyond a cherry red, because if it receive a higher degree

of heat, the steel undergoes an unfavourable change. The plates, when finished, present a very hard material, which nevertheless will yield to the strokes of the punches and the hammer which they require when the holes become too much enlarged by the frequent passing of the wire through them.

It is to be observed, that when the plates have been repaired several times they acquire a degree of hardness, which renders it necessary to anneal them again, especially when they pass from one size to another; frequently they do not acquire the proper quality until they have been annealed several times.

Notwithstanding all the precautions taken in preparing the plates, the steel still varies a little in hardness; and according to this variation they are employed for drawing either steel or iron wire; but if the workman who proves them finds that they are too soft for either one or the other, they are put aside, to be used by the brass wire drawers.

A plate that is best adapted to drawing steel wire, is often unfit for the iron; for the long pieces of this latter metal will become smaller at the extremity than at the beginning, because the wire as it is drawn through the plate is insensibly heated, and the adhering parts are swelled, consequently become inflated, and the wire is more strongly pressed and reduced in size towards the latter end.

The plates that are fit for brass, are often too soft for iron, and the effect resulting is the reverse of that produced by a plate that is too hard.

The smallest plates that Messrs. Mouchel use, are at the least two centimetres in thickness; so that the holes

can

can be made sufficiently deep, for when not so they seize the wire too suddenly and injure it. This inconvenience is much felt in manufactories where they use the plates for too long a time, as they become exceedingly thin after frequent repairs *.

TO BE CONCLUDED IN OUR NEXT.

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## *List of Patents for Inventions, &c.*

(Continued from Page 256.)

DAVID COCK, of Dean-street, Soho, in the county of Middlesex, Stereotype Manufacturer; for vessels of a new construction for melting metals and heating fluids. Dated February 1, 1810. Specification to be enrolled within six months.

AUGUSTUS FREDERICK DE HEINE, of Moor-lane, Fore-street, in the City of London, Gentleman; for certain improvements on printing and stamping presses. Dated February 1, 1810. Specification to be enrolled within two months.

JOHN CRAIGIE, of Quebec, in the Province of Lower Canada, in North America, Esquire, now residing in Craven-street, in the county of Middlesex; for certain inventions of his own; and a method of making an

* One only of Messrs. Mouchel's large plates reduces 1400 kilograms, from the largest size to No. 6, which is of the thickness of a knitting needle. 400 kilograms, of this number, are afterwards reduced in one single small plate to No. 24 of the carding wire, and to end they are passed through twelve times successively.

From this observation, it may be concluded that they are very perfect.

improved

improved kitchen fire-place, communicated to him when residing abroad. Dated February 1, 1810. Specification to be enrolled within two months.

STEDMAN ADAMS, of the City of Hartford, in the State of Connecticut, in North America, Esquire; at present residing in Carey-street, Lincoln's-inn-fields, in the county of Middlesex; for certain improvements on steam-engines and in distillation. Dated February 1, 1810. Specification to be enrolled within six months.

WILLIAM MULLER, of the Hay-market, in the county of Middlesex; for certain improvements in the construction of pumps. Dated February 12, 1810. Specification to be enrolled within two months.

JOHN SLATER, of Birmingham, in the county of Warwick, Coach-spring Maker; for his improvement in hanging and securing grind-stones from breaking in the middle or centre. Dated February 12, 1810. Specification to be enrolled within two months.

WILLIAM DOUGHTY, of Birmingham, in the county of Warwick, Engineer; for his improvement in the combination of wheels for gaining mechanical power. Dated February 12, 1810. Specification to be enrolled within six months.

GEORGE WYKE, of the city of Bath, Esquire; for certain improvements in the construction of wheel carriages of various descriptions. Dated February 12, 1810. Specification to be enrolled within two months.

PETER WARBURTON, of Corbridge, in the county of Stafford, China Manufacturer; for a new method of decorating china, porcelain, earthen-ware, and glass, with native, pure, or adulterated gold, silver, platina, or other metals, or fluxed or lowered with lead or any other

other substance; which invention leaves the metals, after being burned, in their metallic state. Dated February 13, 1810. Specification to be enrolled within two months.

RICHARD WITTY, of the town of Kingston-upon-Hull, Gentleman; for certain improvements in making, arranging, and combining certain parts of rotative steam-engines, by which means the most complete parts of the steam engines now in use are dispensed with and rendered unnecessary, and the whole of the mechanism made much more simple, less expensive, and not so liable to be out of repair as that of the steam engines now in use, and applicable to giving motion to all sorts of mill-work or machinery. Dated February 14, 1810. Specification to be enrolled within two months.

ÆNEAS MORRISON, of the town of Greenock, in Scotland; for a machine for conveying persons from the upper parts of houses on fire, and for lowering goods from warehouses and other purposes. Dated February 22, 1810. Specification to be enrolled within six months.

PETER STUART, late of Fleet-street, in the city of London, Printer; for a method of engraving and printing maps of countries, charts, or other plans or designs, music, mathematical diagrams or figures, on wood, metal, or any other substance, so that they may be thrown off in a common printing press or presses, either for books, newspapers, or any other printed paper whatever. Dated February 26, 1810. Specification to be enrolled with two months.

WILLIAM BAINBRIDGE, of the parish of Saint Andrew Holborn, in the city of London, Musical Instrument-maner;

maker; for certain improvements on the English flute or flageolet. Dated February 26, 1809. Specification to be enrolled within two months.

MAJOR PRATT, of Spencer-street, Saint George in the East, in the County of Middlesex, Farmer; for certain methods of manufacturing machines for performing various agricultural operations by mechanical powers. Dated February 26, 1810. Specification to be enrolled within six months.

AUGUSTUS DE HEINE, of Burr-street, in the county of Middlesex, Gentleman; for certain apparatus, by the application of known principles, to preserve animal food, vegetable food, and other perishable articles, a long time from perishing or becoming useless. Dated February 26, 1810. Specification to be enrolled within six months.

CHARLES LE CAAN, of the town of Llanelly, in the county of Carmarthen, Gentleman; for certain apparatus to be added and united to the axle-trees and wheels, or naves of wheels of carriages, so as to impede, resist, or check their action. Dated February 26, 1810. Specification to be enrolled within two months.

JOSEPH STEPHENSON, of Mortimer-street, Cavendish-square, in the county of Middlesex, Plumber; for a machine for filtering and purifying of water. Dated February 27, 1810. Specification to be enrolled within two months.

THE

# REPERTORY

OF

# ARTS, MANUFACTURES,

AND

# AGRICULTURE.

No. XCVI. SECOND SERIES. May 1810.

*Specification of the Patent granted to* AUGUSTUS FREDERICK DE HEINE, *of Burr Street, East Smithfield, in the County of Middlesex, Gentleman; for Improvements on Printing and Stamping Presses.*

Dated February 1, 1810.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Augustus Frederick de Heine do hereby declare, that my said invention is fully ascertained by the drawings in the margin, and the following description thereof; that is to say: Instead of applying a screw for my power, I apply two sectors, or a sector and cylinder, or a sector and roller, to move one against the other, by a single or compound lever.

Fig. 1, (Plate XVII.) represents the head of the piston, under which is the platen or dye.

Fig. 2, represents the same in a side view; in the centre is a hole in which the spindle moves by a lever.

Fig. 3, represents the moveable spindle with two opposite sections.

Fig. 4, is the same in front view. The lever, single or compound, is fixed to the spindle, as in Fig. 5, representing a common press frame, A is the regulating screw with a male centre B, C is the moveable spindle, Fig. 3, on which a single lever is fixed. It is evident that by bringing the lever from X to Y, as in Fig. 6, the piston will be depressed, as in the common screw, with this difference, that as the descent of the piston decreases in velocity, the power must increase in the same proportion; in the screw the descent is equal, consequently the power is equal. This motion may be reversed, by putting the opposite sectors at the top of the piston, and the cylinder or roller on the moving spindle, this will produce the same effect. Or in case this power is applied to a fly press, it may be applied by putting the part that acts instead of a screw, like Fig. 3 or Fig. 4, the part M uppermost through the hole in the head of the press at B, Figs. 5 and 6, and fixing the fly-lever above the head of the press; then by turning the spindle by the fly-lever, the sectors will act in the manner of a screw with an increasing power. The sectors and the part which comes in contact with them must be made of iron, steel, brass, or any other hard substance; I prefer steel or iron case-hardened; the snegs of the sector, and the diameter of the moveable spindle, are made as circumstance requires, and can be varied ad infinitum.

In witness whereof, &c.

*Specification*

Fig. 1.

Fig. 2.

Fig. 3.

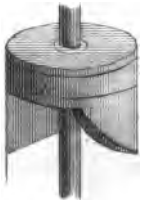



Fig. 4.

Fig. 5.

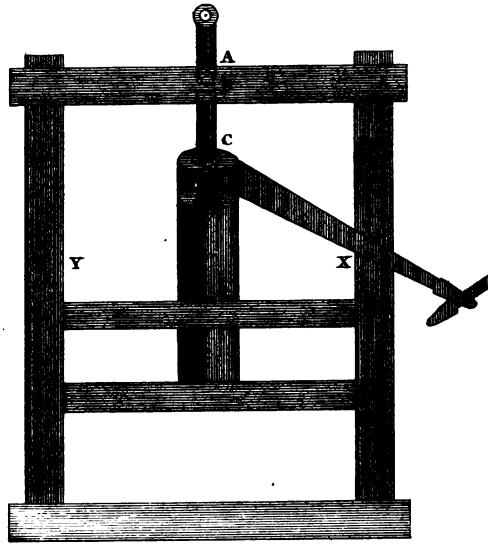
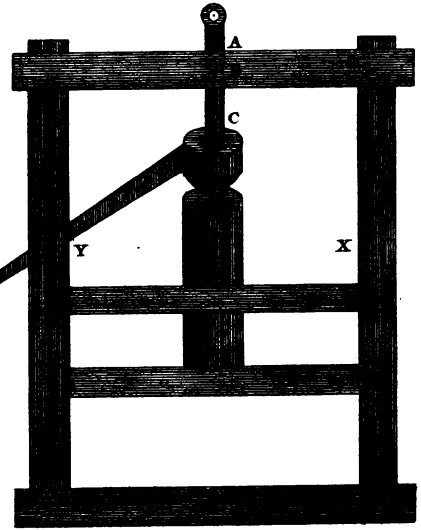



Fig. 6.



*Specification of the Patent granted to* CHARLES VALENTINE, *of the Parish of St. James, Clerkenwell, in the County of Middlesex, Japanner; for a new Mode of ornamenting and painting all Kinds of japanned and varnished Wares of Metal, Paper, or any other Composition, and various other Articles.* Dated March 20, 1809.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Charles Valentine do hereby declare, that my said invention is described in manner following; that is to say: In the first instance, to produce a painted or gilded effect of a landscape, figure, or ornament, &c. &c. on the surface of any painted, varnished, or gilded body, or bodies, intended to be painted, varnished, or gilded, whether of wood, metal, paper, or any other composition whatever, it will be necessary to procure four pieces of copper, which I number 1, 2, 3, and 4, or any other hard metal, exactly of one size. On the piece, No. 1, must be engraved or etched, either in lines, acquatinter, dots, or hatches, whichever is preferred, the strongest light of the figure, ornament, or landscape: on the plate, No. 2, must be engraved the second shade: on the plate, No. 3, must be engraved a darker shade; and on the plate, No. 4, must be engraved the darkest shade: next procure some fine fan tissue or other soft paper, which is to be strongly prepared with gum arabic, isinglass, or any other glutinous body dissolved in soft-water: the proportion about a pound to one quart of water: the paper is easily prepared by the striking a brittle tool charged with the solution separately over every sheet: then procure some strong burnt linseed oil, and grind a sufficient proportion

of Frankfort black till you have produced an ink of thick consistence for the darkest shadow. For the second shade, mix a little flake white; for the third shade, add more flake white; and for the lightest, pure flake white: then charge the four plates with the different shades, and cover the plate, No. 4, which is charged with the darkest shade with a piece of the above prepared paper rather wet, and pass it through a Printer's rolling-press: having obtained the darkest impression, cover the plate, No. 3, exactly with the same paper, and pass it a second time through the press; then damp the back of the impression with a moist sponge, and cover the plate, No. 2, exactly as before, and pass it a third time through the press; then cover the plate, No. 1, which has the strongest light, exactly as before, and pass it a fourth time through the press: the impression must then be suffered to dry in the air for the space of a week till the shades are perfectly dry (unless assisted by heat, which is apt to cocle the paper), then mix with copal varnish the back ground of whatever shade you please, and cover exactly with an even coat with a camel-hair pencil the whole of the shadows from outline to outline, taking care the colour is of sufficient body, which entirely depends on the thickness of the varnish: let the whole harden in the air for the space of a day or two; then prepare the surface of the wood, metal, paper, or composition that is to receive the impression, with a thin coat of copal varnish; and when it has dried a little, so that when the finger is gently pressed upon it, will leave a faint impression on the varnish; then apply the prepared impression or painting in the most even manner on the back or painted side of the impression on the varnished surface, and gently press it down with a sponge

sponge well moistened with warm-water, till the whole is evenly laid: suffer it to lay a quarter of an hour in its wet state, till the gum with which the paper is prepared is dissolved; and you may then wash with the greatest ease with a sponge the whole of the paper away, and leave a finished painting of four shades on the surface of the chosen body; great care should be taken that the shades are sufficiently dry before the back ground is applied, or they would be materially injured by the application; likewise if the paper is not sufficiently gum'd, there will be great difficulty to obtain a release of the painting: when the whole is sufficiently dry, they may be varnished and stoved as other regular japan work. When more lively or brilliant colours are required than those described, they must be ground with strong burnt linseed-oil, and the plates charged as before described: where only a plain impression of any mezzotint, acquatint, stipple, line or dot engraving is wanted, on the surface or ground of any gilded, or varnished, or painted body, without any opake back ground, it may be done in the most expeditious manner as follows: prepare a weak solution of gum-water, by dissolving a quarter of a pound of gum-arabic in a quart of soft water, and prepare the fan or fine tissue paper as before described; charge the plate and obtain the impression in the like manner, apply the paper while wet with the painted side downwards on the surface of the body intended to receive it, and gently press it down with a moist sponge: suffer it to remain a few minutes in its moist state, then raise the edge of the paper and gently pull it off: the paper will readily leave the impression, and come clear off. The body that has received the impression may then be stoved in as great a heat

heat as it will bear, and whatever shadow you may think necessary to put may be applied when dry by transparent colours well ground and mixed with copal varnish. Where the strokes and hatches of the engraving are required to appear in gold upon any painted or varnished surface it will be necessary to gild the surface, and secure it by a coat of copal varnish, which you must suffer to dry quite hard: then prepare it as before described by a second coat of varnish; then grind a small proportion of virgin's wax with the printing-ink, and take off the impression on the prepared fan or fine tissue paper as before described: gently press it down on the gold surface with a moist sponge; suffer it to dry for a few days in the open air; then mix what colour you please for the ground with a small proportion of copal varnish, and cover evenly the whole surface of the gold with a thin coat: suffer the ground to dry in the air, then warm the body of the composition on which the subject is printed, and gently rub the surface with a piece of cotton: the heat will readily dissolve the ink and wax, and discover the gold on every part where the lines of the engraving have laid. Engraving on box and hard wood are better adapted to produce this effect than those on copper or hard metals; the impressions may be as readily obtained on the prepared fan paper, by using the letter press instead of the rolling press. Impressions and ornaments may be obtained from blocks cut, carved, or engraved on holly, box, or some hard bodies, which may be charged with japan gold size instead of painting ink, and passed through a letter press on the prepared papers; and by a moist sponge the impression may be conveyed upon the surface of any painted or varnished body, suffering it to remain a few hours

hours to dry, may be gilt or bronzed, or gilt with gold leaf, the same as if the gold size had been applied by the pencil. In witness whereof, &c.

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*Specification of the Patent granted to* JOSEPH MANTON, *of Davies Street, Berkeley Square, London, Gun-maker; for improved Time-keepers.*

Dated December 5, 1807.

With a Plate.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Joseph Manton do hereby declare that my said inventions in time-keepers, consist of an instrument or machine for time-keepers to act in vacuo so constructed, that they may be wound up in vacuo when required, without admitting the external air, as is hereafter described in the explanation of the annexed drawing: which is the section of an instrument or machine for keeping a time-keeper in vacuo, and the manner of winding up in vacuo. A A, Fig. 1, (Plate XVIII.) is a round plate of brass made perfectly flat, to which the stop-cocks B B are connected, by the flat shoulder or flanch *a a*, and secured by four screws, of which *b* represents one. B B two stop-cocks, the stoppers of them C C, are kept close in their places by the collets *c c*, fitted square on the ends, and held down by the screws *a a*, drawing the stoppers to any degree of tightness. At the end of the stop-cocks B B, is a circular box E E, screwed in at D, with a leather between the shoulders, the bottom of this box has a socket or tube *e*, screwed into it, and the tube *e* has cemented within it a barometrical gauge F F, with a scale G G of inches and parts

parts attached thereto, to show the state of vacuum the time-keeper keeps time in, and also to prove the various joints and component parts are positively air tight. By comparing the height of mercury in the gauge with a barometer, the perfectness of vacuum will be ascertained. Within the circular box E E, is a contrivance *f*, which precludes the possibility of the mercury getting up or into any part of the apparatus, for if the mercury passed the tube *e*, it would strike against the concave or under side of *f*, and then return to its proper place. At the right hand end of the stop cocks B B, is a pipe *g*, connected to the stop cocks by the screw nut H; the inner shoulder or bottom of this nut bears on the shoulder *h*, of the pipe or tube *g*, and fixes it securely; this pipe is used only to connect the instrument or machine to an air-pump, for the purpose of exhausting, which being done, it is then disengaged by unscrewing the nut H, afterwards unscrewing the box E E, it is also taken away with the barometrical gauge and scale, leaving the instrument or machine conveniently portable and inclosed in the box or case I I; *k k*, a ring of brass within which the receiver *r r r r* is placed; L L, a mirror to show the vibrations of the balance which otherwise could not be advantageously seen; *l l*, a thin ring of brass surrounding the edge of the mirror L L, and preserving it from any damage; *n n*, a thin ring laying between the underside of the mirror L L; and the upper surface of the plate A A, thereby leaving a space or passage for the air to pass through the hole M of the mirror, into the holes *m m m m*, of the stop cocks B B, and through which the air passes when the instrument or machine is being exhausted; N N, a ring of brass grooved and supported by four pillars, two

of

Fig. 1.

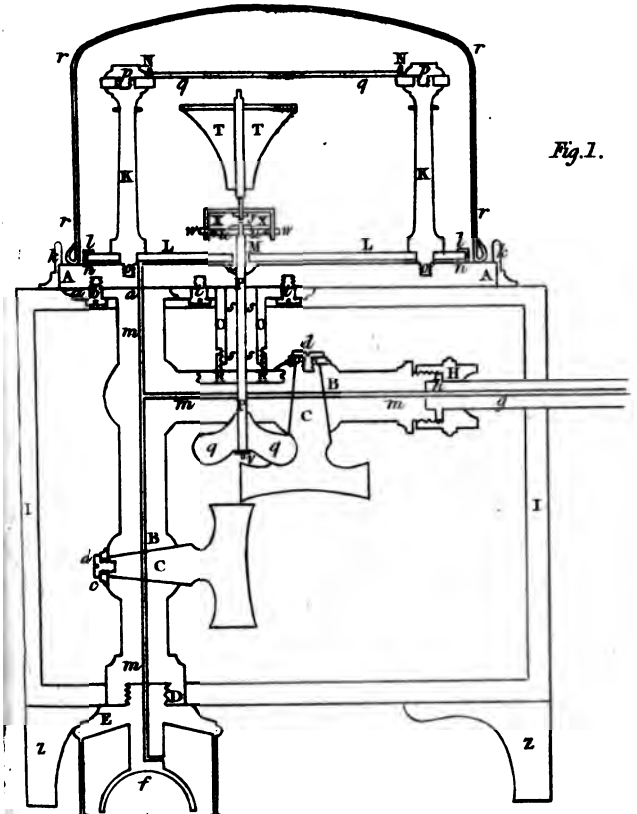



Fig. 2.

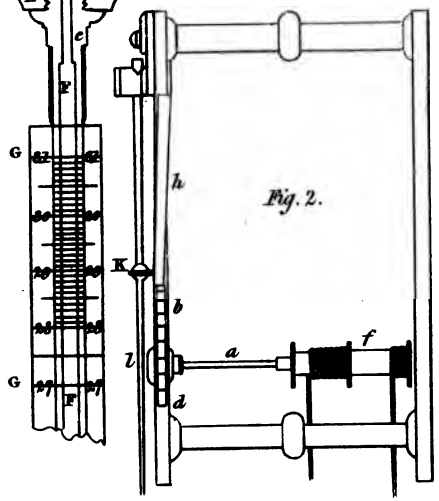
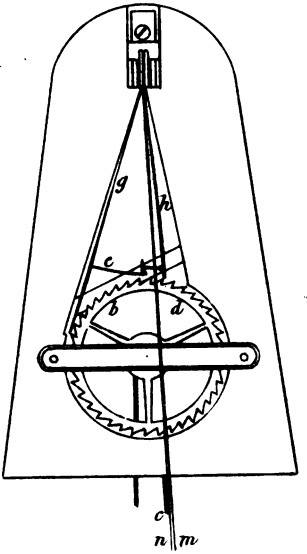



Fig. 3.



of which, K K, are shown with their ends passing through the mirror at *o o*, and screw into the plate A A; this ring is fastened to the top of the pillars K K, by the screws *p p*; *q q*, the dial plate or face of the time-keeper fitted into the groove or recess of the ring N N, and fastened by small screws, so that the fusee of the time-keeper is perpendicular, and precisely opposite to the winder P P; *r r r r* a glass receiver, the bottom of it made perfectly flat and greased, or rubbed with linseed oil which has been boiled until it is of a thick consistence, to unite close with the upper surface of the plate A A, and which effectually prevents any air from entering; O O, a hollow socket with a flat shoulder or flanch fastened to the under side of the plate A A, with four screws, two of which are shewn at *t t*, containing collars of leather (which have been well soaked in oil or grease) *s s s s*, which are close fitted on the steel cylinder or winder P P; and the outer edge of the leathers are as closely fitted within the hollow socket O O, and kept tightly pressed together by the screw nut R R, thus forming a continued tube of leather, and through which tube the cylinder or winder passes; *z*, a chamfered or square sunk hole for holding oil to supply the cylinder or winder; T T is the fusee of the time-keeper; P P the winder is a cylinder of steel, having on the lower end a thumb-piece or cross lever *q q*, fitted on square and fastened by the small screw nut *v*. On the upper end of the cylinder or winder is a cross piece of steel *u u*, having jointed at the ends on opposite sides the pieces *w w*, which are kept strait by two springs. To the fusee T T, is fixed a staple piece X X, made fast by the small screw nut *y*. To wind up the time-keeper, the cylinder or winder P P is pushed upwards until the

cross-piece *w w* comes in contact with the staple piece X X; the time-keeper is then wound up by turning the cross-lever *q q*, it is then pulled down and thus disengaged from the fusee. If through incaution the cylinder or winder should be improperly turned, yet no harm would ensue to the time-keeper, for then the pieces *w w* are thrown forward contrary ways to each other, and thus would pass or clear staple piece X X, and immediately resume their proper situation, being forced back by the springs already described acting against them. I I, a box or case having one or more sides to open for the purpose of winding up the time-keeper, &c. &c. Z Z, two of the brackets of the box or case. The advantages of time-keepers going in vacuo are, the unequal pressure of the atmosphere will be prevented; for when the air is heavy the vibrations of the balance or pendulum are retarded; when the air is light, they are accelerated; but by these inventions of time-keepers going in vacuo, the vibrations of the balance or pendulum will be more uniform; the sea air, damps, and dust, which are so injurious in rusting, corroding, and clogging the movements of time-keepers are totally excluded. The oil in vacuo will be also preserved in a more uniform fluid state, and not so liable to be glutinous as when exposed to atmospheric influence. Great care should be taken to have a good air pump so as to exhaust the air as much as possible; for the more perfect the vacuum, the more correct will be the motion of the balance or pendulum.

These inventions of time-keepers to go in vacuo, and to be wound up in vacuo when required without admitting the external air, will be of great advantage in being applied to clocks or watches. The form, or shape, and manner

manner of constructing or making the apparatus of the instruments, or machines, or the materials, or the substances they are made of, for containing time-keepers, clocks, or watches in vacuo may be varied; also, the materials, or the substances, or the form, or the shape and manner of constructing or making the instrument or machine for winding time-keepers, clocks, or watches, when in vacuo may be varied, provided that no external air is admitted. In witness whereof, &c.

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*Specification of the Patent granted to* PETER WARBURTON, *of Colridge, in the County of Stafford, China-manufacturer; for a new Method of decorating China, Porcelain, Earthen-ware, and Glass, with native, pure, or adulterated Gold, Silver, Platina, or other Metals, or fluxed or lowered with Lead, or any other Substance; which Invention or new Method leaves the Metals after being burned in their Metallic State.*

Dated February 13, 1810.

TO all to whom these presents shall come, &c. NOW KNOW YE, that in compliance with the said proviso, I the said Peter Warburton do hereby describe and ascertain the nature of my said invention, and in what manner the same is to be performed, in manner following; that is to say: My invention consists in decorating china, porcelain, earthen-ware, and glass, by means of printing instead of painting upon the same, with such preparations of gold, silver, and platina as are made use of by painters, to produce the metallic appearances called burnished gold and silver, and steel lustre, and which have hitherto been effected by painting only. In the application of this invention I employ gold, silver, and

platina in the three following methods: First method of printing; I take an impression from a plate of copper, or any substance on which an engraving can be made, in the following manner. The necessary oils are rubbed with a boss into the figure. Landscape or design engraved on the plate. The plate is then cleaned with the hand, or otherwise, in order to take off all the oils except what fill the part on which the figure, landscape, or design is engraved; a substance composed of glue and isinglass, called by potters and printers a bat, is then applied to the plate, and the impression is taken off by means of a boss or a roller. The impression is then transferred from the bat to the earthen-ware, china, or glass, intended to be decorated by means of a boss; after which such preparations of gold, silver, and platina, as are employed by painters to produce the metallic appearances, called burnished gold and silver, and steel lustre, being previously dried and reduced to a state of powder, are laid on the piece of china, earthen-ware, or glass, intended to be decorated, with cotton wool, or any substance fit for the purpose; the gold, silver, or platina, adhering to that part only which has received the impression as above described: it is afterwards cleaned with silk, cotton, or any substance fit for the purpose, and then put into the oven or kiln in the usual way.

Second method. I charge or fill the figure, landscape, or design, engraved on a plate of copper, or any substance on which an engraving can be made, with the necessary oils: the plate is then cleaned with the hand, or otherwise, in order to take off all the oils except what fills the parts in which the figure, landscape, or design is engraved. Potters printing-paper, being previously sized in the usual way, is then applied to the plate, and

the

the impression is taken off by means of a potter's printing-press, and transferred from the paper to the earthenware, china, or glass intended to be decorated, by means of flannel, or any substance fit for the purpose. The aforesaid preparations of gold, silver, and platina, being previously dried and reduced to powder, are then laid on with cotton, wool, or any substance fit for the purpose; the gold, silver, or platina adhering to that part only which has received the impression as above described. It is afterwards cleaned with silk, cotton, or any substance fit for the purpose, and then put into the oven or kiln in the usual way.

Third method. I mix such preparations of gold, silver, and platina as are made use of by painters to produce the metallic appearances called burnished gold and silver, and steel lustre, with the necessary oils. This mixture, in a liquid state, is then laid upon the figure, landscape, or design engraved on a plate of copper, or any substance on which an engraving can be made, and rubbed in with a dabber: the plate is afterwards cleaned with a piece of leather, or any substance fit for the purpose, called by printers a handcuff or a hand boss. Potter's printing-paper, being previously sized in the usual way, is then applied to the plate, and an impression of the figure, landscape, or design is taken off by means of a potter's printing-press, and transferred to the earthen-ware, china, or glass intended to be decorated by means of a rubber. The paper is then taken off, leaving thereon the impression, and it is afterwards put into the oven or kiln in the usual way. Gold, silver, and platina must be printed upon the glaze of earthenware and china; gold, silver, and platina, printed upon earthen-ware, china, or glass, in burning, burnishing, and

and in all other respects, are treated in the same manner as gold, silver, and platina laid on with a pencil are treated.

In printing with gold and silver, I have found my first and second methods the most advantageous; in printing with platina my third method is the best.

It would be useless to describe the composition of the oils and the bats, the same being well known, and equally useless to describe, the processes by which gold, silver, and platina are rendered capable of being employed by the painter and by the printer, these processes not being of my invention.

In witness whereof, &c.

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*Account of a Method of driving or forcing forwards Ships or other Vessels by the Power of Steam-Engines. By Mr.* JAMES LINAKER, *Master Millwright of Portsmouth Dock-yard.*

*Communicated by the Inventor in a Letter to the Editors.*

GENTLEMEN,

I SHALL be obliged if you will insert in an early number of the Repertory, the inclosed account of a method of navigating vessels by the power of steam-engines, for which I obtained the King's Patent July 14, 1808. The account is a faithful extract from the specification enrolled in Chancery, with the omission only of the references to drawings, which are very extensive, would put you to considerable expense to have engraved, and I apprehend are unnecessary to be copied into your work, as the invention is fully described in that portion of the specification which I have inclosed to you.

I need

I need not point out the many cases where a vessel propelled by a steam-engine would be very advantageous for making a certainty of performing short voyages; as, for example, between England and Ireland, and from port to port on the coast, or to the neighbouring coasts of the Continent, for any purposes. Such a vessel might also be used with great advantage for inland navigation, and at many ports as a towing vessel, to take ships out of port a certain distance, so as to get into the wind that would then enable them to proceed on their voyage, when this same wind is against their getting out of port, and the ships would otherwise remain wind-bound for a long and uncertain period.

By some experiments which I have made on a heavy boat thirty-one feet long, with a single bucket acting horizontally in a trunk, agreeably to the first method described in my specification, with the power of eight men employed to work it by hand, the boat was moved at the rate of three miles and three quarters *per* hour. I have no doubt, from what I observed in these experiments, made under many disadvantages, that a proper sea-going vessel might be driven by a steam-engine in the manner I propose at the rate of six miles *per* hour.

I am, Gentlemen,

*Portsmouth Dock-yard,* Yours, &c.

*Feb.* 10, 1810. JAMES LINAKER.

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*Extract from the Specification.*

The first method of my invention for the purpose of towing, driving, or forcing forwards ships or other vessels, consists in applying a bucket, similar to the bucket of a lifting-pump, to be moved or worked by any sufficient

cient power backwards and forwards in a tube or trunk attached to the said ship or vessel, in a direction parallel, or nearly so, to the direction of the intended motion of the said ship or vessel; which ship or vessel is to be moved forward upon the water by the effect of this bucket drawing the water in at one end of this trunk and delivering it out at the other, in a direction parallel, or nearly so, but contrary to the direction of the motion of the said ship or vessel; for this purpose the bucket and trunk must be provided with valves, after the manner of a lifting-pump.

The second method of my invention, for the purpose aforesaid, consists of an improvement upon a method where a forcing-pump has been used for the same purpose; but in lieu of admitting or drawing in the water by the piston of the forcing-pump perpendicular to the direction of the intended motion of the ship or vessel, I admit or draw in the water, by the said piston of the forcing-pump, in a direction parallel, or nearly so, but contrary to the direction of the intended motion of the ship or vessel, through a tube or trunk attached thereto; by this means, combining the effect of admitting or drawing the water in, along with the effect of forcing the water out in the best direction for giving the intended motion or impulse to the said ship or vessel.

Any power may be made use of with either of my aforesaid methods, and any of the common means of shafts, levers, rods, wheels, and racks for transmitting the powers. I do not claim the power or the means of transmitting it to the buckets and piston as my invention. I however consider the steam-engine as generally the best power to be applied to my aforesaid methods.

*Description*

## *Description of a Clock Escapement, invented by Mr.* GEORGE PRIOR, *jun. of Otley, in Yorkshire.*

With Engravings.

From the TRANSACTIONS of the SOCIETY for the Encouragement of ARTS, MANUFACTURES, and COMMERCE.

*The Silver Medal and Twenty-five Guineas were presented to Mr.* PRIOR *for this Invention.*

THIS escapement will do for a pendulum of any length, and the friction is so small that it does not require any oil, for it may be made as little as the tooth of the wheel can sufficiently touch the impelling spring, and yet be properly scaped.

It is necessary that the detent spring, the impelling spring, and the pendulum should all spring from one right line or centre, and the impelling spring to be so much stronger than the detent spring as will always be sufficient to unlock the wheel.

The machine being wound up, and the pendulum put in motion towards the left side, the impelling spring unlocks the wheel, when a tooth falls against the pallet, where it remains until the pendulum returns; then moving the impelling spring, and the wheel being free, the weight on the axis causes it to advance while it escapes one tooth off the end of the pallet or spring, and another tooth is locked against the detent spring, as before, while the pendulum returns, and the impelling spring again unlocks the detent; as the impelling spring moves towards the left, the resistance it meets with by the elasticity of the detent spring in unlocking is returned to it,

so that there is no more power lost than what was caused by the pressure of the wheel against the detent spring; by which means it is freed from the loss of the maintaining power, which is evident in all detached escapements I have seen, by the pendulum or crutch, &c. touching a spring or lifting a lever to regain the position for unlocking the wheel.

P. S. The screw in the pendulum rod is to adjust the machine when fixed up.

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REFERENCE TO THE ENGRAVING.

Fig. 2 (Plate XVIII.) is a side, and Fig. 3 a back view of it, which is supposed to be taken from behind the clock; *a* represents the axis of the swing wheel, or last wheel of the train of the clock; *b d* is the swing wheel fixed upon it, having 30 serrated teeth; it is turned round in the direction from *b* to *d*, by the maintaining power of the clock, (in the model this power is supplied by the descent of a small weight attached to the end of the small line, which is coiled round the barrel *f*, on the axis of the swing wheel); *g* is a spring detent, which locks against one of the teeth of the swing wheel, and this prevents its running down, by the action of the maintaining power; *h* is another spring detent, which is called the impelling spring; when left at liberty, it unlocks the former by pushing against the end of the small arc *e*, Fig. 3, fastened to the detent *g*, and thus removing the end of the detent which obstructed the wheel's motion; *c* is the rod of the pendulum suspended by a cock screwed to the back plate of the clock, a small piece of brass projects K, Fig. 2, at right angles from the impelling spring *h*, so as to intercept the pendulum

dulum rod in its vibration, and at this place a small screw is put through the pendulum rod *c*, the point of which moves the impelling spring back; a small pin is fixed to the frame in a line between the point of suspension of the pendulum, and in the centre of the swing-wheel, against which the impelling spring stops when at liberty.

Supposing the pendulum to be vibrating backwards and forwards, and the wheel locked as in the figure, the pendulum swinging from *m* to *n*, Fig. 3, the impelling spring *h* follows by its elasticity, until the pendulum *c* arrives at the perpendicular; at this period the impelling spring comes to rest against the end of the arc *e*, which it pushes back, so as to release the tooth of the wheel from the detent spring *g*; the wheel now moves round a very small space before it meets the end of the impelling spring *h*, and is stopped thereby; in the mean time, the pendulum continues its motion the extent of its vibration towards *n*, when it returns; and arriving at the perpendicular, it meets the impelling spring *h*, and carries it along with it, until the tooth of the wheel which rests against it, escapes from the end of it, and another tooth of the wheel comes to rest against the spring detent *g*. The succeeding vibration of the pendulum repeats the same operation.

## *On the Art of Printing with Stone, and especially on the Progress which this Art has made in Germany.*

*By* M. MARCEL DE SERRES.

From the ANNALES DE CHIMIE.

THE art of printing with stone was originally discovered in Germany, and has since spread into England, Italy, and very lately into France. Alois Senefelter, a native of Prague, in Bohemia, is the inventor of this new method of printing, which is known in Germany by the name of *chemische druckerey*, i. e. chemical printing. It is now nine years since he obtained from the king, or, as he was then called, the elector of Bavaria, an exclusive privilege to exercise it for 13 years, but Senefelter afterwards ceded this privilege to his brothers. Some time afterwards, the same Senefelter also ceded this privilege to M. Andre, of Offenbach, who has since carried on the art in England. In 1802, he went to Vienna to solicit a fresh privilege, which he obtained in 1803, from the Emperor of Austria, for the term of 10 years. Being very wavering in his mind, he abandoned this privilege to Messrs. Steiner and Krasnitzki and returned to Bavaria, where, having arrived at Munich, he opened, in partnership with some other persons, a stone-printing-house. Messrs. Steiner and Krasnitzki have kept up the practice of this art at Vienna, being supported in their design by Startl de Luchsenstein, a councillor of the regency, who warmly interests himself in whatever is useful.

The stone-printing-house established at Munich, is that where the art has been brought to the greatest perfection, and that at Stutgard appears to be much less important. M. Chauvron is the first who obtained in France

France a brevet of invention to print, or engrave with stone, and M. Guyot Desmares has only engaged in it since his time.

The processes which are used in printing with stone, are very simple; but as only a very short description of them has been given in the Annales de Chimie, vol. XLI. p. 309, it will be useful to treat of those at least which are practised in Germany.

At Vienna, they use three different methods of printing with stone; but it must be observed that they most commonly use that which is called the method in relief.

The method of which the greatest use is made, is, as has been just said, the method in relief; this method is mostly used for music.

The second method that is employed, is the hollow method, and this is preferred for engravings.

The third method is the flat method, or that which is neither hollow nor in relief. This is very useful for the imitation of drawings, and particularly of those drawings which are to be made like those which have been drawn with chalk.

To print or engrave according to this process, a slab of indurated marle, or any other calcareous stone is used, provided the stone can be easily cut, and takes a good polish. These stones may thus be compared to the copper-plates, or wooden blocks, for which they are indeed substituted. The size of the stone, as may be easily judged, should be in proportion to that of the work which it is meant to engrave upon them. It ought to be from 2 inches to 2 inches an half thick: it is necessary, however, to observe that this thickness is not absolutely necessary; but it is very convenient to make use of a stone of this thickness, in order that it may last longer.

longer. A good polish ought to be given to the stone, and this polish ought to be in some degree granular: it also appears that a small grain, although the stone is in some measure porous, is a desirable advantage. At Vienna slabs of marle brought from Bavaria are used; this marle is quarried at Sollenhoffen, near Sapenheim. It is very fortunate, that as the interesting art of printing with stone is established in France, stones that possess all the necessary qualities have been found near Paris.

When the stone is dried, and well polished, the next operation is to draw the design, notes or letters, that are intended to be printed upon it with a pencil. The design traced in this manner is not sufficiently apparent; and in order to render it more so, a particular kind of ink is retraced over the mark of the pencil. This ink is considered at Vienna as a great secret; it appears to be formed of a solution of gum lac in potash, which is afterwards coloured with lamp-black produced from burning wax. When the letters or notes are marked with the ink just now described, the ink is left to dry, most commonly for the space of two hours. As to this indeed, the time that is required to dry the ink depends so much upon the temperature and humidity of the air, that nothing positive can be said about it; but the most ignorant workman will easily be able to determine when the ink is dry. It must be again observed, that the ink, whose composition has been just described, is coloured with lamp-black made from burning wax. It is this black that has been found most convenient for this kind of printing.

When the letters or musical notes impregnated with black are dry, there is passed over them nitric acid, (*i. e.* aquafortis), more or less diluted, according to the relief

or

or hollow which it is desired to form upon the stone. The acid attacking all parts of the stone but those which have been impregnated with the resinous ink, only the notes or drawing remain untouched.

The slab of marble is then washed with water, to render it clean; and a printer's ball is charged with an ink analogous to that used in other kinds of printing. It is only the letters or notes that take the ink from the printers ball, so that they are found to be properly coloured. After this, a sheet of paper being put in a frame, the frame is lowered, and a brass cylinder is passed over the paper, or a copper press is used. Thus an impression is obtained, the neatness of which depends of necessity upon that of the design. These copper presses are well made in Germany, and they are easily used; their weight is in proportion to the method that is used in the engraving. At each proof it is necessary, as in all other kinds of printing, to wash the plate with water, to pass over it the printing roller or press, after the letters or notes have been inked again with the common printer's ball, in order that they may mark the paper.

When the number of copies it was meant to print are finished, and it is not intended to make any farther use of the work, the stone is polished again, and thus the same slab will serve for thirty or forty different works. The method called the hollow method, in German *kreide manier*, does not differ greatly from the method in relief, except that the nitric acid is made to act stronger upon the stone, so that the letters are more relieved and the stone itself much hollower. This method is principally used by the engravers; and it has this advantage over the other methods, that it remedies that equality of tone which printing from stone produces in the works.

It

It is easy to be conceived, that the highest parts will take up less of the colour, and the hollow parts more, so that the print thus managed has a less mononous effect than is usual, and which defect has always been against this manner of engraving. Besides this, the hollow method requires much stronger rollers, and particularly that they should be heavier. As, therefore, in this method it is necessary to go to more expense, it has been totally left off, nevertheless it ought to be preferred for those engravings which require some effect and much neatness. Nitric acid, almost pure, is employed in this method, and indeed pure nitric acid was always used when printing from stone was first used; its dearness, however, led to its being weakened with water, and now it is diluted according to the effect that is desired to be obtained.

The method which is called in relief, is that in which nitric acid is used with one half of water. This method is called in German by the name of *erhabene*, and is principally employed to print music: as scarcely any thing but music is engraved at Vienna, it is almost the only method they use. To print in this manner, the pressing rollers that are used are not so heavy as those employed in the hollow method.

The third method, called the flat manner, and in German *erflach*, is particularly advantageous for engravings imitative of drawings in chalk. Less nitric acid is used in this method, but great care must be taken that the stone which is prepared for this purpose is quite flat. Although the letters rise very little, they do nevertheless stand up above the surface; but it is less sensible than in the other methods, and can scarcely be discovered but by the touch.

The

The kinds of work that are engraved on stone are the following:

1°. Imitations of wood cuts.
2°. Imitations of the dot manner.
3°. Drawings.
4°. Musical works.
5°. All kinds of writing.
6°. Geographical maps.
7°. Engravings in mezzotinto.

The advantages which result from the manner of printing or engraving that has been described above, are, that this printing has a peculiar character which cannot be imitated by the other methods of printing, and that it can easily imitate any of the former. But its greatest advantage is the quickness with which it may be performed in proportion to the other kinds of printing.

A design which an artist could not finish upon copper in the space of five or six days, may be engraved upon stone in one or two days. While the copper plate-printer draws off six or seven hundred impressions, the printer from stone can take off in the same space of time 2000 impressions. An engraved copper plate will seldom yield 1000 impressions; but the stone slab will yield several thousand, and the last will be every whit as good as the first. It has been tried in the stone-printing-office at Vienna to take off 30,000 impressions of the same design; and even then the last impression was nearly as handsome as the first. They have even carried this number of copies to a greater extent, in printing bank notes.

The most industrious and most skilful engraver of music can hardly engrave four pages of music on pewter in a day, while the engraver on stone may engrave

twice as many in the same time. Every kind of work which artists engrave upon copper or pewter, and which the printer executes with moveable types, may also be performed by using stone.

It would take up too much time to enter into all the details of the expense of this method of printing; but experience shews that printing upon stone may be performed with a saving of one-third of the expense, in comparison of the printing upon copper or pewter.

After having thus exhibited the advantages resulting from this method of printing from stone, it is but right to point out its disadvantages. The principal of these disadvantages is the difficulty that occurs when it is attempted to give, either to the characters of the impression or to the strokes of the engraving, that diversity of tone which renders these two kinds of works valuable in the eyes of those who look for beauty in every thing. Thus, for example, the most beautiful engravings that printing from stone has hitherto produced, are certainly those that have been executed at Munich after the famous drawings which Albert Durer, by a very common caprice among painters, had traced upon a book of prayers *. These engravings are performed with much spirit: the strokes are frequently very fine, but it is too equal, so that the engraving is rather gray, and uniform. It is principally by comparing these engravings with those of the same subject which other masters have executed in etching with aquafortis that the difference will be most perfectly perceived. In the

* Alberecht Durers Christlich mythologische handzeichnungen. Strixner. Munchen. 1808. Different coloured inks have also been used in printing the designs. Black and red ink have been employed, as alo violet and green ink.

latter

latter it is soon observed that the engraving tool has been directed so as to give the necessary force to the line, thus rendering it sometimes strong and sometimes fine, as it would be in a drawing, and that still there is no stiffness in it. But in the engravings upon stone that have been hitherto published, neither this freedom can be perceived, nor the strength which adds so much to the relief of the engravings performed with aquafortis.

The same inconvenience is also to be found in the music printed in this manner, and the equal tint that is spread over it also renders the music less legible. It must not, however, be hastily concluded from this, that the new art is not important, but only that some method of avoiding the inconveniences which appear to arise only from the processes now used, should be sought after. If these methods should be discovered, which may be expected from a more extended experience in the art, particularly in the manner of applying the acid, and of drawing upon the stone, which are indeed the two most essential points to bring to perfection, this method of printing will unite an economy of time with that of expence. The great number of impressions that can be obtained by this method is not one of its least advantages. And lastly, it is certain that the discovery of printing from stone is an important discovery for the arts, because it is a new one, and offers some real advantages.

It now only remains to speak of the differences that appear to exist in the printing-houses on this plan which are established in different cities. It seems that at Milan they pour upon the stone a little nitric acid diluted with water as at Vienna; but it is asserted, that they cannot take off more than 500 impressions; a circumstance

which propably depends upon the nature of the stone that they use there, and which is brought from Verona.

It seems that Chauvron, the first who established a printing-house of this kind at Paris, having first traced the lines upon the stone with resinous ink, contents himself with moistening the stone with water. He then wipes off the water lightly, which soon leaves the resinous lines, and leaves them quite dry. On applying after this printers' ink by means of the common balls, the ink does not adhere to those parts of the stone which remain impregnated with moisture, and of course it is only the resinous lines that yield any impression. Chauvron is said to have printed a considerable quantity of music in this manner.

It ought to be observed, that in those printing-houses where they do not make use of nitric acid, they always produce a very inferior kind of work, and can only take off a very small number of impressions. It therefore appears that the use of nitric acid cannot be too strongly recommended; and after what has already been said, the reason is evident.

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## *On the purified Juice of Deadly Nightshade as a Test for Salts.* By Dr. G. MELANDRI.

From the ANNALES DE CHIMIE.

THE analysis of deadly nightshade, *atropa belladonna*, has occasioned the discovery of a salt in the leaves of this plant, which till this time had not been found in vegetables, namely, oxalate of magnesia along with free oxalic acid: the other substances which this analysis presented, were oxalate of lime, muriate of potash, a

soft

soft green resin, animal extractive matter, mucous matter, and oxygenizable extractive matter.

The examination of the fruit of belladonna has also occasioned the discovery of a re-agent for acids and alkalies, which is quite as accurate as the tincture of purple hollyhock, *alcea purpurea.*

If, for example, alcohol be poured upon the expressed juice of the ripe fruit of this plant, the purple liquor coagulates, and the mucous matter is precipitated; if then this coagulum be carefully washed with the same alcohol, and the alcohol filtered, a tincture will be obtained, which, being diluted with water until the colour of it is no longer to be perceived, will become green when mixed with alkalies, and red with acids.

After some time, the purple colour changes to a yellow; but, notwithstanding this change, it is so far from losing its power as a test, that it will even discover the minutest quantity of acid or of alkali in water.

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*Observations on the Proportions of Elements in some Compounds. By* M. C. L. BERTHOLLET.

(Concluded from Page 300.)

M. RIFFAULT * relates that Laugier, in concert with M. Vauquelin, made four experiments to determine the composition of nitrate: the mean result gave

62 potash,
38 acid,

100

On

* Translation of Thompson's System of Chemistry, vol. IV. M. Riffault, who has for a long time observed, with great care, the operations in which salt-petre is manufactured, affirms that the evaporation which is attributed to this salt does not really take place.

On the other hand, according to Mr. Kirwan, 100 of potash neutralize 84.96 of nitric acid; which gives for 100 of nitrate of potash,

54.06 potash,
45.94 acid,

100.00

According to Richter, 100 of nitrate of potash are composed of

53.3 potash,
46.7 acid,

100.0

Adopting the experiment of Thenard, which differed very little from mine, but in which the nitrate contains less water, and making the correction which the water retained by the potash we employed requires, 100 parts of potash take 94.6 of nitric acid; and 100 parts of nitrate of potash, free from water, are composed of

51.38 potash,
48.62 acid,

100.00

4°. I had observed that 100 parts of potash require, to become neutral, 158.815 of sulphuric acid, of 141.70 specific gravity. Making the correction that I have adopted, 100 parts of this acid contain 88.58 of real acid; 100 parts of pure potash require for their neutralisation 70.94 of real sulphuric acid; and 100 parts of sulphate of potash, free from water, are composed of

place. Not only, says he, the experiments, which have for a considerable time been made to ascertain this, do not confirm it; but it is moreover evidently proved by the results of the refining houses of nitrate of potash, that this evaporation of the salt, by means of watery vapour, is an erroneous idea.

58.50

58.50 potash,
41.50 sulphuric acid,

100.00

5°. 100 parts of potash, such as I employed, required for their neutralisation 85.51 of phosphoric acid in the state of glass, and afterwards dissolved in water; and I obtained 150.19 of phosphate of potash, heated in a strong fire, from whence I concluded that phosphoric glass retains at least $\frac{3}{4}$ of its weight of water. Making the corrections which my new observations led to, it appeared that 100 parts of potash, subtracting the water, require 99.01 of phosphoric glass, and that the compound afford 73.91 of phosphoric acid. It follows, that phosphoric glass contains very nearly $\frac{1}{4}$ of its weight of water instead of $\frac{3}{4}$.

The recent experiments of M. Berthier confirm the existence of water in phosphoric glass, he even attributes to this body a larger quantity than I have assigned. The difference probably may depend on the circumstance, that the phosphoric glass which I employed in my experiment was kept a long time in an intense heat, or it may have originated in some cause that escaped observation.

After having discovered, that water retained by the elements of a compound, and abandoned afterwards when the compound itself is submitted to the action of fire, was the cause of error in estimating their proportions; I endeavoured to ascertain whether the salts that I used to determine what I considered the real acid and alkali, truly indicated their quantities free from all water foreign to their composition.

I had the most reason for expecting to find water in the

the salts, which exhibit a strong action upon this liquid, such as the deliquescent salts: in fact, I heated muriate of lime in a platina crucible in a strong forge fire; I exposed it afterwards with iron filings in a reverberatory furnace, a large quantity of hydrogen gas was evolved, which, detonated with oxygen, afforded a considerable proportion of carbonic acid. To satisfy myself that the carbon contained in the gas uniformly came from the iron, though in the preceding experiment very soft iron had been employed, I exposed muriate of lime in a porcelain crucible to an intense heat; the fire was allowed to subside, distilled zinc was added, and to avoid every suspicion of moisture, the fire was raised whilst a tube for conducting the gas was luted to the neck of the retort; a large quantity of hydrogen gas was disengaged, which by analysis with oxygen over mercury did not give any traces of carbonic acid. But in two similar operations the retort was broken, and the neck obstructed by the metal which sublimed; these inconveniences induced me to employ iron in the other experiments, those made with zinc being sufficient to demonstrate that the carbon combined with the hydrogen came from the iron.

Sulphate of lime which had lost by the action of fire 21.9 *per cent.* was submitted to this trial, and it afforded a considerable quantity of inflammable gas.

Of all the salts, sulphate of barytes appeared to me most likely to abandon all its water, by the action of a strong heat: this sulphate was exposed to the strongest fire of a forge during an hour, so that the Hessian crucible which contained it was entirely deformed; it was then immediately introduced into a porcelain retort with iron turnings, and placed in a reverberatory fire; a remarkable

markable quantity of hydrogen was disengaged. This sulphate, as well as the sulphate of lime, was in part converted into sulphuret.

It appears, then, that salts intensely heated obstinately retain water: it should not therefore excite surprize that these bodies should furnish hydrogen: in operations, when treated with the metals, we obtain inflammable gas; but it is easy to conceive that salts which are very soluble in water should retain it most abundantly.

Thus, strictly speaking, the acid indicated by the weights of the elements of a compound ought not to be considered as real acid totally void of all foreign water: yet it is necessary that art should have some limit, that it should stop at a term which is easily ascertained; and it is convenient to assume for real acid, that which is indicated by this trial; but every precaution possible should be taken to employ saline compounds, which by their insolubility announce the least action upon water.

The action of iron itself cannot indicate the whole quantity of latent water in the experiments I have just described; for it ought to cease at the period when it is incapable of surmounting the effects of the opposing affinities. It is reserved for the beautiful series of experiments, with which M. M. Gay-Lussac and Thenard have enriched the science, to make known the quantities of potash and soda which, independent of water, exist in saline combinations.

The end of my experiments at least has been to seek after new determinations of the proportions of salts, as well as to discover the errors which may originate in the water, retained by the elements before combination; it

now remains for me to shew that the numbers I have adopted to determine the quantity of this water, do not verge far from the truth.

And to begin, barytes brought into a liquid state, and kept in this state during nearly ten minutes, constantly gives results which indicate that it contains nearly 9 or 10 *per cent.* of water, from which it is free, when prepared by means of nitrate of barytes.

That which proves that the quantity of water retained by potash, after it has been kept in fusion till it begins to vaporate, and which it abandons when exposed in combination to the action of fire, approaches very nearly to 13,64 *per cent.* at which I have fixed it, is, that in adopting this number, numbers very nearly the same as those obtained by the most accurate analysis, will follow for the determinations I have made in this memoir: the truth of this remark is evident from the tables to be found in Thompson's excellent system of Chemistry.

Thus Bucholz gives for the proportions of muriate of potash, subtracting the water of crystallisation, and establishing the numbers indicated by muriate of silver.

66.37 potash,
33.63 muriatic acid,

100.00

and I conclude the proportions to be

66.66 potash,
33.34 acid,

100.00

The same complete agreement does not appear in the determination of the elements of sulphate of potash, because in the ordinary way of making the estimation by

by sulphate of barytes, slight differences in the proportions of the elements of the salt are frequently adopted. Thompson has given from his own analysis, for the constituent parts of sulphate of potash excluding water,

56.69 potash,
43.31 sulphuric acid,

and my experiments with potash give

58.50 potash,
41.50 sulphuric acid,

100.00

There is a greater disagreement between the determinations of the elements of nitrate of potash, which are indeed very difficult to fix; yet it appears that the numbers which I have given following the results of my own experiments, hold very nearly the mean between the differences.

The alterations which the observations contained in this memoir require, in the proportions of most of the saline compounds which I had employed to establish the capacities of saturation of different acids and alkalies, render it of course necessary to make correspondent alterations in the determination of the capacities themselves; but if the principle which to me appears incontestable, that alkalies and acid exhibit a constant agreement of capacity of saturation, I know that many proportions yet are to be established or verified, before these relations can be represented in a table, in which entire confidence may be placed.

*A comparative Examination of the Mucous Acid formed by the Action of the Nitric Acid upon Gums, or upon Sugar of Milk. By Mr.* A. LAUGIER.

From the ANNALES DE CHIMIE.

MR. VAUQUELIN has proved, by the experiments he has made on gum-arabic and gum tragacanth (related in the 54th volume of the Annales de Chimie) that a very considerable quantity of lime exists in these immediate principles of vegetables.

The reading of his paper suggested the following reflexions:

1°. What becomes of the lime contained in gums when they are treated with nitric acid, for the purpose of preparing mucous acid?

2°. Does not the lime combine with the oxalic acid which is formed nearly at the same time with the mucous acid?

3°. Is not the oxalate of lime, which is not so soluble in water as the mucous acid, precipitated along with that acid when the residuum of the operation is washed; and does it not sensibly alter the properties of it?

4°. What are the means by which the presence of oxalate of lime could be discovered in the mucous acid obtained from gum; and in what manner could this calcareous salt be separated from the acid, whose purity it diminishes?

With a view to resolve these problems, the following experiments were undertaken.

One part or 60 grammes, (4 oz.) of gum tragacanth was digested in eight parts, 480 grammes, of pure nitric acid at 36° hydr. the mixture was heated until it was reduced

duced to the consistence of honey, and then a sufficient quantity of water was added.

A white pulverulent substance was left undissolved, which was collected upon a filtre, and when dried in the air weighed 9 grammes and an half, this was mucous acid. The liquor containing the soluble part of the mixture had a yellow colour, it was evaporated, and was not taken from the fire until the moment when it became covered with a light pellicle which formed at its surface. This liquor deposited immediately, on cooling a great quantity of crystals, some in flakes, and others in needles, which were easily recognised for oxalic acid. In order to separate this last acid from the mucous, alcohol at 40° hydr. was poured upon the mixture, which dissolved the oxalic acid without having any action upon the mucous, so that this was collected upon the filter. This second portion of mucous acid weighed 2.10 grammes. The alcoholic solution yielded, by a gentle evaporation, a coloured mass, which was re-dissolved in water in order to obtain whiter and purer crystals than before.

The mother waters of this second portion of mucous acid, and of oxalic acid, contained a mixture of oxalic and malic acids which were separated from one another by means that are not described here, because they would lead us away from the principal object of these experiments.

The first portion of mucous acid that was obtained weighed 9 grammes and an half; it was very white; and had, when dried, a granular appearance like starch, and this was the acid that was employed in the following experiments: the second portion being neglected, because it did not appear to be equally pure.

For the purpose of discovering the presence of oxalate of

of lime in mucous acid, one part of the above-mentioned nitric acid was mixed with 10 parts of distilled water, and this mixture was poured upon the 9 grammes and an half of mucous acid. The whole was then exposed to a heat of 40 or 50 degrees, during twice 24 hours, taking the precaution of shaking it from time to time in order to accelerate the action of the solvent. The supernatant liquor was poured off, and in this liquor ammonia immediately caused the precipitation of a white earthy salt in silky filaments, which had all the physical properties of calcareous oxalate.

A second portion of diluted nitric acid added to the matter deposited from the preceding liquor, and left on it for the same time, yielded, by the addition of ammonia, a fresh parcel of oxalate of lime.

It required the successive addition of eight portions of weak nitric acid to entirely exhaust the mucous acid, submitted to the experiment, of oxalate of lime. Every time ammonia was added to the decanted and filtered liquor, it separated from it a quantity of calcareous oxalate, the proportion of which diminished each time in a very sensible manner. The ninth portion shewed only some traces which could not be duly appreciated.

The eight precipitates, when united, gave for their total weight 2.3 grammes.

It was of importance to ascertain, if this substance, which was foreign to the nature of mucous acid, the characters and appearance of which appeared to be similar to those of oxalate of lime, was really that calcareous salt.

With this intent, the substance was boiled with a solution of saturated carbonate of potash, and when the reciprocal decomposition of the two salts was finished, the portion

portion that was precipitated was collected upon a filtre. This precipitate was not so white as the original calcareous salt, and was in a much grosser powder; it dissolved with much effervescence in nitric acid. The solution had a sharp, biting taste, it was not precipitated by ammonia, but very abundantly by oxalate of ammonia.

The liquor which swam over this carbonate of lime, and contained an excess of carbonate of potash, was super-saturated with acetic acid and evaporated to dryness; the residuum was treated with alkali in order to separate the acetate of potash from the oxalate with the same base, which is not soluble in that liquid. This mixture, being heated for a few minutes, was flung upon a filter: the oxalate of lime remained upon the filtre, while the alkaline acetate passed through along with the alcohol.

The part that was insoluble in this liquid was dissolved in distilled water; a drop of this solution mixed with half a spoonful of lime-water, threw down a powdery precipitate, which was known to be oxalate of lime, and the same solution yielded, on evaporation, crystals of oxalate of potash.

The experiments just now related leave no doubts respecting the nature of the calcareous salt, whose presence diminishes the purity of the mucous acid obtained from gum tragacanth.

The same experiments being repeated upon gum arabic, and upon that known in trade by the name of Bussora gum, which is insoluble in water, yielded very nearly the same results.

It was observable that as fast as the mucous acid loses the oxalic acid which rendered it impure, by the action of nitric acid, it takes a flocculent appearance.

Scheele

Scheele who discovered mucous acid, called it the saclactic acid, because he had obtained it by treating sugar of milk with nitric acid. This denomination has now ceased to be appropriate, since experience has shewn that it may be procured, by the same means, from the gums. This motive determined Mr. Fourcroy to substitute the name of mucous acid to that of saclactic.

But is the mucous acid yielded by sugar of milk perfectly similar to that which is obtained from the gums? Is it altered as that is by the admixture of a very sensible quantity of oxalate of lime, or does it contain a less quantity of that calcareous salt, or even none at all? It was a legitimate object of curiosity to discover the solution of these questions, and no time was lost in applying the process just described to the examination of the mucous acid yielded by sugar of milk.

In consequence of this determination, one part of sugar of milk was boiled with 8 parts of nitric acid of the same degree of strength as had been used in the former experiments. The first portion of mucous acid that was formed was separated by decanting the liquid, and a fresh quantity of nitric acid was added to the residuum. A second portion of mucous acid was then deposited, which being added to the former, the total weight of the two parcels amounted to 12 grammes, or one-fifth part of the sugar of milk that was operated upon.

It was remarked that when the washing was finished, the mucous acid on being diffused through water had the same flocculent appearance as the acid from gum, which acid had been previously deprived of its oxalate of lime by dilute nitric acid. This circumstance led to the belief that the present acid was purer than that from

gum,

gum, and the supposition was soon confirmed by its being found that nitric acid had no action upon it. The nitric acid did not, even by a long digestion, take away the smallest quantity of oxalate of lime, for ammonia did not render the supernatant liquor in the smallest degree turbid.

Besides this, no doubt was left respecting the perfect purity of the mucous acid obtained from sugar of milk, from the circumstance of its being easily and totally soluble in boiling water. This complete solubility in boiling water shews that it is certainly much purer than the mucous acid from gum, even when this last mentioned acid had been purified by the methods indicated above; for in reality when the mucous acid of gum was purified from the oxalate of lime that it contained, it still left, when it was boiled in distilled water, an insoluble flocculent substance forming 6 *per cent.* of its weight, which being dried, formed a grey horn-like matter, semitransparent, and very similar in its appearance to the mucous substance that connects the particles of animal concretions together, and yet when flung upon burning charcoal it did not yield the ammoniacal and fetid smell given by animal substances, and it yielded carbonate of lime on being calcined. The very small quantity that was procured did not allow the trials to be made, which would have been necessary to form a clearer opinion respecting the nature of this substance.

From the facts related in this essay, the following consequences may be drawn.

1°. There exists a very remarkable difference between the mucous acid procured from gum, and that which is obtained from sugar of milk, by the action of nitric acid.

2°. This difference consists in the former acid being always altered by a mixture of a portion of oxalate of lime in proportion as gum contains that earth; while the mucous acid of sugar of milk does not shew the least trace of that calcareous salt, and appears to be perfectly pure.

3°. The mucous acid of gum may be brought to the same degree of purity by a very simple process, which consists, 1°. in abstracting from it, by successive digestions of very weak nitric acid, all the oxalate of lime that it contains; 2°. in afterwards boiling it in water, which dissolves the pure acid, and leaves the flocculent substance which resisted the action of nitric acid.

4°. The mucous acid of gum being thus separated from the substances foreign to its nature is perfectly similar to that of sugar of milk, possesses all the properties which characterize that acid, and might be employed with the same advantages in the most delicate experiments, requiring mucous acid of the utmost purity.

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Since the preceding essay was drawn up, it has been discovered that there are circumstances in which mucous acid obtained from gum, is found to be mixed with mucite of lime instead of the oxalate already mentioned. This circumstance takes place when nitric acid, diluted with water, is substituted in the preparation of the mucous acid, instead of concentrated nitric acid, and of course the operation is conducted slowly, instead of proceeding in a hasty manner. The difference in the result which is obtained may be easily explained.

When the weak acid is employed, mucous acid is first produced alone: it is then precipitated and draws down along with it the lime with which it forms a slightly soluble salt; and this salt may be separated from the mixture

ture before the oxalic acid, that requires the acid to be concentrated, is formed. If, on the other hand, concentrated nitric acid is employed, the two acids, although they are always formed in succession, are produced very nearly together, and it may be easily conceived that in this case the oxalic acid as fast as it is formed unites with the lime, in consequence of the very great attraction that it has for that earth.

Another fact now to be related exhibits a singular property of mucous acid, which will be examined hereafter with more attention than can at present be given to it.

When the solution of pure mucous acid in boiling water is evaporated slowly to dryness, without separating the crystalline deposition that is formed during the evaporation, it is observable that as soon as all the liquid has disappeared, the crystals grow yellow, then brown, and become converted into a tenacious, as it were viscous substance, which underwent a kind of fusion, and became very hard on cooling.

Mucous acid thus changed had a more acid taste than usual, it was much more soluble in water, and was entirely soluble in alcohol, so that some of its properties were changed. It was at first conceived that the mucous acid had been changed by this means into either malic acid or tartarous acid; but the trials that were subsequently made in order to justify this supposition, did not appear sufficient to form a decided opinion on the nature of the change which took place in the experiment just now related.

## *On the Relation that exists between the Oxidation of Metals and their Capacity of Saturation for Acids.*

*By Mr.* GAY LUSSAC.

From the MEMOIRES D'ARCUEIL.

IT has been long known, that some metals precipitate others from their acid solutions in a metallic state. Bergmann has remarked, expressing himself according to the theory then adopted, that the phlogiston of the precipitating metal passed into the metal precipitated; and moreover MM. Sylvester and Grothuss have shewn, that when once the precipitation is commenced by chemical affinity, it is continued by a process purely galvanic. Notwithstanding the principal phenomena which accompany this precipitation have not escaped the attention of chemists, there is no knowledge of the relation that exists between the quantity of the metal precipitated and the precipitating metal: of course, the important consequences which belong to this knowledge are equally concealed. I purpose to determine this relation, and to prove that the quantity of acid which different metals require for their saturation, is directly proportionable to the quantity of oxygen they contain. I have been led to this principle, not by a comparison of the known proportions of metallic salts, which are commonly too inaccurate for any law to be derived from them; but by observing the mutual precipitation of metals from their acid solutions.

When indeed a solution of acetate of lead is precipitated by a plate of zinc, a beautiful vegetation is produced known by the name of *Arbor Saturni*, the form of

of which is owing to the reduction of the lead by a galvanic process. There is obtained at the same time a solution of acetate of zinc, equally as neutral as that of the lead was, and entirely free from the last metal. No hydrogen, or at most an exceedingly small quantity, is disengaged during the precipitation; a circumstance that proves that the oxygen necessary for the zinc to dissolve and saturate the acid, was entirely afforded by the lead.

If a large proportion of well polished iron turnings is thrown into a solution of sulphate of copper slightly acidulated, the copper is almost instantaneously precipitated, the temperature is much raised, and no gas is evolved. The sulphate of iron obtained is, that in which the metal is at the minimum of oxydation, and its acid state is precisely the same, as that of the sulphate of copper employed.

Similar results are obtained in decomposing acetate of copper by lead, particularly with the assistance of heat. But since zinc precipitates lead from its solution in acetic acid, the conclusion is unavoidable, that it should also separate copper from this acid. Experience, in this instance, happily agrees with the theory.

The facility with which copper precipitates silver from its nitric solution is well known. All the oxygen necessary for the acid to dissolve the copper is furnished by the oxyd of silver; for no gas is separated, and the state of the acid is unaltered.

The same phenomena occur when copper acts on nitrate of mercury, or cobalt on nitrate of silver. In these last examples, as well as in the preceding, the precipitating metal finds in the oxyd of the metal which it pre-

precites

cipitates all the oxygen necessary for its oxydation and for neutralizing in the same degree the acid of the solution.

These facts which appear to me incontestable, naturally lead to the principle that I have announced, viz. that the acid in metallic salts is directly proportionable to the oxygen in their oxyds. For since the precipitating metal finds in that which is precipitated, all the oxygen necessary for its oxydation and for saturating in the same degree the acid of the solution, it follows that the quantity of oxygen in each oxyd is the same, and of course so much less of the precipitating metal is dissolved, as its affinity for oxygen is greater. Thus if two metals are supposed, one of which requires twice as much oxygen as the other, twice as much of the second as of the first will be dissolved to neutralize the same quantity of acid.

It is then proved that when zinc, iron, lead, copper, silver, cobalt, and mercury precipitate each other from their solutions in the metallic state, the precipitating metal finds in that which is precipitated all the oxygen necessary for its oxydation, and for neutralizing in the same degree the acid of the solution. The other metals should likewise exhibit the same property; but I proceed to point out some circumstances which render it difficult to determine whether this is really the case.

If muriate of antimony is precipitated by zinc, a compound effect is produced. This salt requiring a great excess of acid, and the muriate of zinc being capable of existing almost in the neutral state, it happens that, when the zinc takes oxygen from the antimony, it decomposes water and produces consequently hydrogen gas. It is possible that, though the salt to be precipi-

tated

tated is neutral, the salt resulting from the precipitation may not possess that property; in this case, the precipitated metal is more or less mixed with oxyd. Lastly, the precipitating metal may exert a very powerful action on the acid of the solution, decompose it and give a complicated product. This occurs when nitrate of copper is precipitated by zinc*: one portion of the metal decomposes one portion of the acid, and the resulting oxyd precipitates oxyd of copper, which mixes with the metallic copper. But these particular facts are not opposed to the principle which I have established: on the contrary, in conformity with it, a very satisfactory explanation may be given.

The oxyds which I have hitherto considered are principally those which Mr. Proust has called oxyds at the *minimum*, and it may be asked whether those at the *maximum* possess the same properties; that is to say, is their capacity of saturation for acids proportionable to the quantity of oxygen they contain?

It appears to me, that there should be no doubts on this subject; for nothing indicates *a priori*, whether the oxyds, which are considered to be at the minimum, are really so; and when even they should be at the minimum or maximum, in respect of the chemical means employed to produce them, it does not follow, that they represent corresponding degrees of oxydation. But without entering into these discussions, which would be foreign to the object I have in view, I shall notice some facts which tend to generalize much the principle which I have established. The facts are few indeed, because almost all the metals, when they become highly oxydated, form salts with a larger or smaller excess of

* Vauquelin, Annales de Chimie, vol. XXVIII. p. 43.

acid

acid which is independent of their saturation, and which has no other effect than that of surmounting the cohesion of the oxyd and preventing its precipitation.

It may first be proved that highly oxydated metals take more acid than those which are less oxydated. Mr. Proust has observed, that mercury, kept some time in corrosive sublimate, becomes converted into calomel; and MM. Fourcroy and Thenard have ascertained by the analysis of these two mercurial salts, that the first contains more acid than the second. White muriate of copper too, by exposure to the air, changes to a green muriate and to an oxyd retaining a little acid; an evident proof that copper takes more acid in proportion as it acquires more oxygen. But it is not sufficient to know that highly oxydated metals take up more acid than those which are less oxidated; it is necessary to shew that the quantity of acid they acquire, is proportionable to their oxydation.

By repeating the distillation of mercury several times with the oxymuriate, the salt is entirely converted into the mild muriate, and neither acid nor oxygen gas is liberated. It is evident then, that there are in the oxymuriate and in the mild muriate, quantities of acid proportional to the quantities of oxygen in the metal. The analysis of these two salts lead likewise to the same conclusion. M. M. Fourcroy and Thenard have found * that the oxymuriate contains 73 parts of mercury and 20 of acid, and the mild muriate 11.6 of acid, and 83 mercury. They have besides ascertained that the red oxyd contains twice as much oxygen as the black; so that in making the calculation to reduce the metal to the same weight in both analysis, it appears that the acid of corrosive

* Jour. of the Polyt. School, vol. VI. p. 338.

ceive sublimate and of calomel calculate exactly with the oxygen of the oxyds of each salt. Comparing in the same point of view the analysis of the muriates of copper by Proust and Chenevix, similar results are perceived.

Thus I think it may be fairly concluded from these facts, that the acid of salts is directly proportionable to the oxygen of their oxyds *.

As a consequence of this principle, it has already appeared, that in decomposing a metallic neutral salt, by a metal capable of forming a neutral salt, no oxygen or acid should be disengaged, providing that both are in convenient circumstances for forming a neutral salt with the decomposing metal.

But the most important result to be derived from the principle, that the acid of salts is proportional to their oxygen, is a very simple means of determining the proportions of all metallic salts. Excepting the proportions of insoluble salts, those of all the others are more or less uncertain, it would be useful to determine them, by making the proportions of acid in metallic salts to depend on those of oxygen in their oxyds.

It is indeed sufficient to know the different degrees of oxydation of the metals to become acquainted with the relative quantities of acid requisite for their saturation; and to arrive at the absolute quantities, it is sufficient to know the proportions of one salt in each genus.

* It is very remarkable that the acid being proportionable to the oxygen of the oxyds, it does not follow the relation of the oxygen when the acid passes from the first degree of acidification to the second. A sulphite, that of lead for instance, take up more acid, if the metal becomes more highly oxydated; but if the acid passes into the state of sulphuric acid, no more oxyd will be taken up. I do not know how to account for this difference.

As the first example, I shall take the muriates; and I shall suppose, averaging the experiments of several chemists with my own, that muriate of silver contains:

| | |
|---|---|
| Silver | 100,00 |
| Oxygen | 7,60 |
| Acid | 25,73 |

On the other hand:

| | | |
|---|---|---|
| 100 of copper require | 24,57 of oxygen | according to my experimts. |
| Zinc | 24,41 | |
| Lead | 7,29 | M. Berthier. |
| Mercury at the minimum | 4,16 | MM. Fourcroy and Thenard. |
| Mercury at the maximum | 8,21 | |

Allowing these data and the principle that the capacities of metals for acids are proportional to the quantity of oxygen they contain, the proportions of the muriates deprived of water will be as follows:

| | | |
|---|---|---|
| Muriate of lead | 100,00 | lead. |
| | 7,29 | oxygen. |
| | 24,68 | acid. |

Mr. Kirwan has found in this salt 24,02 of acid. If a calculation is made on the proportion of the acid according to the analysis of sulphate of lead, by M. Berthier, and in conformity with the capacities of muriatic and sulphuric acid, deduced from the analysis of sulphate and muriate of barytes by the same chemist, the result is 24,55; which agrees very exactly with 24,68, the number I have just given.

| | | |
|---|---|---|
| Muriate of copper | 100,00 | copper. |
| | 24,57 | oxygen. |
| | 83,18 | acid. |

M. Proust has found instead of the last number 74,74.

| | | |
|---|---|---|
| White muriate of copper | 100,00 | copper. |
| | 12,28 | oxygen. |
| | 41,59 | acid. |

MM.

MM. Proust and Chenevix have found 39,5.

| | | |
|---|---|---|
| Muriate of mercury (calomel) | 100,00 | mercury. |
| | 4,16 | oxygen. |
| | 14,08 | acid. |

MM. Fourcroy and Thenard have found 13,97.

| | | |
|---|---|---|
| Oxy-muriate of mercury (corrosive sublimate) | 100,00 | mercury. |
| | 8,21 | oxygen. |
| | 28,16 | acid. |

The same chemists have found 27,39.

Following the proportions of sulphate of lead given by M. Berthier, those of the other sulphates are easily found.

| | | |
|---|---|---|
| Sulphate of lead according to M. Berthier | 100,00 | lead. |
| | 7,29 | oxygen. |
| | 37,71 | acid. |
| Sulphate of copper | 100,00 | copper. |
| | 24,57 | oxygen. |
| | 127,09 | acid. |

M. Proust has found 128,46.

| | | |
|---|---|---|
| Sulphate of zinc | 100,00 | zinc. |
| | 24,41 | oxygen. |
| | 126,26 | acid. |

M. Tennant has found 124,41.

If one wished to determine by experiment the proportions of the sulphits, many difficulties would occur, because the sulphits very readily pass into sulphates; but they might be estimated from those of the last salts.

I have proved (Mem. of the Society of Arcueil), that sulphuric acid may be reduced by heat to two parts in volume of sulphureous gas and one of oxygen gas. It is known beside that a sulphit is converted into a sulphate, without the neutral state of the salt being altered; consequently the capacity of sulphurous acid is to that of sulphuric acid, as the weight of two parts

of sulphurous gas, plus one of oxygen gas, is to that of two parts of sulphurous gas; that is to say, adopting the specific gravity of oxygen gas given by Lavoisier, and that of sulphurous acid by Kirwan :: 2,83 : 2,076. Multiplying then the proportion of the acid of each sulphate by this first number 0,8037 that of each corresponding sulphate will be obtained.

Thus there is found for the sulphate of lead { 100,00 lead. 7,29 oxygen. 30,30 acid.

Lastly to give another example of the calculation to be made to determine the proportions of the salts of the same genus, I shall take the phosphates and admit with M. Berthier, that

The phosphate of lead is composed of { 100,00 lead. 7,29 oxygen. 31,14 acid.

On this datum the following proportions result from calculation :

Phosphate of copper { 100,00 copper. 24,57 oxygen. 104,95 acid.

Phosphate of zinc { 100,00 zinc. 24,41 oxygen. 104,27 acid.

Phosphate of mercury at the minimum { 100,00 mercury. 4,16 oxygen. 17,76 acid.

Phosphate of silver { 100,00 mercury. 7,60 oxygen. 32,46 acid.

Since then it is in one's power, the proportions of one metallic salt and the oxydation of the metals being given

given, to determine those of all the salts of the same genus, one may also, the proportions of acid and oxyd in all the metallic salts, and the oxydation of one metal being given, calculate that of all the others. Thus on the supposition that the analysis of sulphate of lead which I have availed myself of, is exact, and that of sulphate of barytes (66,5 of barytes and 33,5 of acid) given by M. Berthier, is likewise so; it will be found that the new combustible substance extracted from barytes, will require for 100 parts 10,77 of oxygen. Also admitting the analysis of muriate of soda, which M. d'Arcet has communicated to me, *viz.* 50,73 of alkali and 49,27 of acid, it will be found that the new combustible substance extracted from soda requires 40,21 of oxygen; about four times as much as the preceding.

It is known that lead, silver, and mercury, at the minimum of oxydation, form insoluble salts with most of the acids. These metals are precisely those which form neutral salts, or very nearly so, take up least oxygen, and consequently least acid. It is easy then to conceive how all the salts, in which the oxyd is at the minimum of oxydation, have a greater tendency to insolubility than those in which the oxyd is at the maximum. It results from this general law, that a compound which possesses much of an insoluble principle, has a greater tendency to insolubility, than one in which the soluble principle predominates. Mercury at the minimum forms an insoluble salt; but when at the maximum it affords a salt which possesses great solubility, all the salts, whose metals require much oxygen, exhibit this property.

I shall not lengthen this memoir, for I am of opinion that I have already advanced facts enough to establish the

the principle, which was my object, and to evince all its consequences.

As the proportions of acid in salts depend on the quantity of oxygen that their bases contain, it would be desirable for chemists to pay great attention to the oxydation of metals, and to the proportions that are most easy to be determined of one or two salts of each genus. The proportions of a great number of salts would be thus obtained, and the advantage would accrue, of calculating the limits of those acid salts as they gradually approach to the neutral state. For it is proper to remark that the excess of acid in a salt is foreign to its saturation, and that it is only necessary to prevent the precipitation of the oxyd, by destroying its force of cohesion. If in fact the oxyds were very soluble, they would all form salts perfectly neutral.

*Observation.*

When metallic solutions are precipitated by sulphuretted hydrogen, either alone or combined with an alkaline base, a metallic sulphuret or hydrosulphuret is obtained. In the first case, the hydrogen of the sulphuretted hydrogen combines with all the oxygen of the oxyd, and the sulphur forms a sulphuret with the metal: in the second, the sulphuretted hydrogen combines directly with the oxyd without effecting its decomposition; and the proportion of the sulphuretted hydrogen is such, that there is sufficient hydrogen to saturate all the oxygen of the oxyd. The quantity of hydrogen which is or may be destroyed, depends as much on the oxydation of the metal, as the quantity of sulphur does which may combine with the metal. Consequently the same metal forms

forms as many particular sulphurets, as it is susceptible of different degrees of oxydation in its acid solutions. And as these degrees of oxydation are fixed, sulphurets should be obtained of constant proportions which might easily be determined from the quantity of oxygen of each metal, and from the proportions of sulphuretted hydrogen. I do not contend that these sulphurets should be the only ones that may be procured; but I think that they ought to be regarded as the true types of the other sulphurets; so much the more so as the proportion of sulphur has an immediate relation to the quantity of oxygen that the metal possesses, and as the oxygen determines the proportions of acid which combines with the metal.

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*Extract from the Memoir of Messrs.* MOUCHEL, *of l'Aigle, in the Department de l'Orne, on the Manufacture of Iron and Steel Wire.*

With a Plate.

(Concluded from Page 317.)

WE left the iron wire at the thickness of a knitting needle: in this state, it is put in bundles of 125 kilograms each, into a large vessel in order to prepare it to be reduced for the last time. This vessel is placed upside down in the middle of a round furnace, which is so constructed as to sustain burning coals all round it, and of which it consumes 35 kilograms before the operation is completed.

The cover must be carefully luted, as the slightest admission of air is sufficient to burn the upper surfaces of the wire, which cannot afterwards be reduced.

When

When one of these vessels is re-placed by another, it is suspended over the flames of the furnace; being previously filled with water, containing three kilograms of tartar.

This solution, without attacking the metal, frees it from the grease and the little oxyd that adheres to it.

This operation is the last in which the wire is exposed to the fire; as it is then in the proper state for being reduced to the degree of fineness it is capable of sustaining, and preserves enough of the effect of the annealing, to require it no more; yet when the natural hardness of the iron varies, this last exposure to the fire should take place in proportion to its thickness; thus as steel loses its capacity of extension much sooner than iron, it is annealed until it is no thicker than a sewing needle. The space which this leaves in the vessel is filled up with charcoal dust, which prevents it from losing the quality of steel, and preserves the heat long enough to give it the proper degree of pliancy.

As Messrs. Mouchel always use iron and steel of the same manufactory, they have been able to reduce their operations to a general system; to attain this end, they had only to find a graduated scale, by which the wire would not be more stretched in the drawing plate, in one number or size than in another. The following is the method they contrived, in order to form this scale for the iron wire: it was found necessary to employ another for the steel wire.

They take a certain quantity of various thicknesses, which has been drawn as fine as the iron would bear *; they note the weight that each might be capable of sup-

* The smallest size is 100.000 metres in length to the kilogram.

porting

porting without breaking; this being expressed by figures, it is easy, by a few changes in their differences, to express them in a progressive form, * from which gauges or calibres may be made, that may be put into the hands of the workmen: these gauges are certain guides, which they cannot mistake except through great carelessness. If they had not these guides, they would often pass the wire through holes in the drawing plate that are too large for it, whence it does not acquire the strength it should have in proportion to its thickness, and consequently loses its hardness. They would also be likely to pass it through holes that were too small, which weakens and renders it very brittle. In the latter case it frequently happens that the steel of the drawing plate being unable to sustain the force to which it is exposed, will give way, as if the plate were too soft; and the wire will be brittle at the beginning, and soft and too thick at the other extremity.

The greatest part of the fine wire of Messrs. Mouchel's manufactory, is drawn by workmen who are dispersed about the country. These workmen have a staple in three of the principal villages, where every week they deliver up the wire they have drawn, and receive a fresh supply, and where their work is examined with the greatest accuracy.

As it was not possible to accommodate all these wire-drawers in one place, the proprietors were long desirous of bringing a certain number of them into their immediate neighbourhood, in order that they might be at hand to afford a daily supply to the establishment. One of their hydraulic wheels was appropriated to the exe-

* This kind of scale has been partly formed, by comparing the weight of the sizes with equal lengths.

cution of this project; and they have established a machine which moves 24 bobbins in a horizontal direction, which only requires the workman to look after the wire. The time that is saved enables him to employ two bobbins at the same time instead of one; and the price of manual labour is thus diminished nearly one-half.

It is upon the bobbins that the wire is reduced to the different degrees of thinness desired; therefore this is the last operation in the art of making iron and steel wire. Yet although it has all the requisite qualities given to it in the workshop of the wire-drawer, it is still incapable of being made into needles and especially carding-hooks; it has still to undergo an operation, which is considered the most difficult and delicate of all; this is the dressage or straightening, by which it is made to lose the bend or curve that it acquires on the bobbins.

This work consists in passing the wire between nails implanted on a piece of wood, and which act against it as so many little vices, the last of which tends to force it into a straight line. For this effect the dresser is obliged to be constantly adjusting the nails, by inclining or raising them with strokes of the hammer. It is requisite that each number be at different and calculated distances. It may be easily imagined that this department requires a workman of intelligence, diligence, and address; but it is impossible for him to succeed entirely. Being convinced of this truth, Messrs. Mouchel have avoided it, by the invention of an instrument appropriated to this operation (see Plate XVI. Fig. 3.) Six little puppets of very hard steel *c c c c c c*, are substituted for the nails of the ordinary instrument, and are fixed on the parallel bars *a b b*, which are widened or brought

brought nearer together by screws. A scale, *m*, sustained by a screw, indicates the distance that the puppets should be from each other to straighten each size. Thus all difficulties are adjusted by an invariable rule; and the dresser (who may be a child), saves a third of the time which is employed in regulating the instrument formerly used. There is nothing more to be done but to draw out the wire by means of a wheel, on which he divides it, and then forms it into bundles to be delivered to the consumers.

At a little distance from the end of the puppets there may be placed at pleasure a light weight, which depresses the beginning of the wire, and which is passed over an index that shews its degree of flexibility.

## Explanation of the Plate.

Fig. 3, a front view of the machine for straightening iron and steel wire intended for needles and carding hooks.

*a a*, the piece of copper to which the machine is attached; *b b b b*, bars, the movement of which is parallel; *c c c c c*, moveable puppets with their bars; *d d d d*, supports of the puppets with a screw to advance or draw them back when in use; *e e*, moveable supports round an axis; *f f*, bars which form a part of the supports; *g g g*, nails which maintain these bars in the proper position, yet without preventing them from following the movement of the parallel bars, so that they shall cross the two last puppets according to the thickness of the wire (these puppets break the sinuosities of the wire); *h*, conductor of the wire to the puppets; *i*, another conductor which serves to prevent the wire from being shaken; *k k*, slides which serve to determine the

position of the bars *f f*; *l l*, the screw with its worm; *m*, scale which indicates the distance of the puppets for each number or size; *n n*, the iron wire.

Fig. 4, side view of the same machine. *o o o o o*, grooves at the extremity of the puppets to give a passage to the wire; *p p p p p p*, screws to press on the puppets; *q q q q q q*, screws, the worm of which passes through the groove *r*, of the plate; *s*, a fixed screw.

Fig. 5, front view of the instrument to determine the suppleness of the wire; it is occasionally added to the end of the machine Fig. 3, *a* the screw which raises and lowers a little weight *c*, which is suspended to the wire *b*; *d*, a groove in which the weight runs; *e*, the scale; *f*, a slide to hold the wire according to its number; *g g*, the numbers of the wire. All the figures 3, 4, and 5, are represented exactly half the size of the real instrument.

The rough steel employed by Messrs. Monchel, is brought from one of the best iron-makers in France; its price is moderate; but if they wish it to possess all the qualities of foreign steel, they procure it from thence in bars, which is equally good, and the same price as what is produced in the neighbouring states.

The steel of France is also proper for many purposes; it is bought from Messrs. Monchel for making knitting needles in the English fashion, shoemakers needles, and other similar articles. It may also be used for needles of all sizes, and even for cards for wool-combing; but as this steel is much more expensive than the iron wire, it is very seldom used for the latter purpose.

Messrs. Monchel have added six kinds of steel, to the collection of specimens of iron wire, which they presented to the Society of Encouragement, which are considered as the best and most difficult to work. They have rendered them

them almost as ductile as iron without altering the quality.

Although the authors have united the steel to the iron wire in their account of the manner of treating it, they nevertheless manufacture each at different establishments, placed on the same course of water, at the distance of a hectometre from each other: they have each their distinct workshops established in a large way.

One of them is a forge to reduce into small irregular bars the steel and iron of Normandy, which arrives in large pieces.

The separation of these two establishments procures to the proprietors the advantage of allowing the hydraulic machine, that draws the steel wire to go slower than that which draws the iron; for the first, as very hard, offering more resistance to the drawing plate, should be pulled out with more care, since the quickness ought to be proportioned to the resistance and reciprocally; for if they depart from this principle, the results will vary: thus, for example, the iron of the department de l'Orne, which is more compact than that produced at Messrs. Mouchel's establishment, situated at Haute Saone, drawn by the same machines, augments in hardness, and is weakened, when it is brought to too great a degree of fineness. But this iron, which is very hard and capable of receiving a very high polish, is, as we have already observed, to be preferred for certain uses, so that Messrs. Mouchel find as ready a market for it as for the softest iron.

We think it may be useful to subjoin to this memoir, the prices of the different numbers or sizes of the iron and steel wire manufactured by Messrs. Mouchel.

*Prices*

*Prices of Iron and Steel Wire manufactured by Messrs. Mouchel.*

| Thick wire of Normandy, without the mark of the pincers. In bundles of five kilograms. | | Steel wire. By the kilogram. | | Wire for cards. In bundles of one kilogram. | | Wire for general purposes. In bundles of five kilograms. | |
|---|---|---|---|---|---|---|---|
| No. 1 | at 10 frs. 55 cts. | No. 0 a 5 | frs. — cts. | Nos. 5 & 6 a 2 | frs. 20 cts. | No. 8 a 10 | frs. 95 cts. |
| 2 & 3 | 10 10 | 1 a 4 | 60 | 7 a 2 | 25 | 9 a 11 | 15 |
| 4 | 9 30 | 2 a 4 | 35 | 8 a 2 | 30 | 10 a 11 | 35 |
| 5 | 8 45 | 3 a 4 | 20 | 9 a 2 | 35 | 12 a 11 | 75 |
| 6 | 8 20 | 4 a 3 | 95 | 10 a 2 | 40 | 14 a 12 | 20 |
| 7 | 8 — | 5 a 3 | 75 | 12 a 2 | 45 | 16 a 13 | — |
| 8 | 7 60 | 6 a 3 | 50 | 14 a 2 | 55 | 18 a 13 | 84 |
| 9 & 10 | 7 45 | 7 a 3 | 40 | 16 a 2 | 75 | 20 a 14 | 67 |
| 12 14 | 7 25 | 8 a 3 | 30 | 18 a 3 | 10 | 22 a 16 | 30 |
| 15 18 | 6 90 | 9 a 3 | 20 | 20 a 3 | 20 | 24 a 19 | 60 |
| the rest | 6 70 | 10 a 3 | 10 | 22 a 3 | 60 | 26 a 25 | 35 |
| | | 11 a 3 | 5 | 24 a 4 | 25 | 28 a 32 | 70 |
| | | 12 a 3 | — | 26 a 6 | 15 | 30 a 49 | 30 |
| | | 13 a 2 | 95 | | | | |
| | | 14 a 2 | 90 | | | | |
| | | 15 a 2 | 85 | | | | |

The memoir of Messrs. Mouchel is accompanied by a great number of certificates from artists and manufacturers, who employ with success the iron and steel wire of this establishment, the good quality of which they attest.

*List*

*List of Patents for Inventions, &c.*

(Continued from Page 320.)

JOHN JUSTICE, of Dundee, North Britain, Ironmonger; for an improvement in the construction of stove-grates, calculated to prevent or cure smokey chimnies, and possessing other advantages over the stove-grates in common use. Dated March 6, 1810. Specification to be enrolled within four months.

THOMAS SCOTT, of Holborn, in the county of Middlesex, Musical Instrument-maker; for an improved German-flute, clarionette, and Oboe. Dated March 12, 1810. Specification to be enrolled within two months.

THOMAS ROBINSON, of Robert's-bridge, in the parish of Salehurst, in the county of Sussex, Brewer; for a mashing machine. Dated March 12, 1810. Specification to be enrolled within two months.

JOHN KENT, of Southampton, Architect; for a new and expeditious method of moving all kinds of goods or materials to high buildings, or from deep places. Dated March 12, 1810. Specification to be enrolled within two months.

THOMAS GRANT, of Biddeford, in the county of Devon, Esquire; for a method of making paint or varnish from a newly discovered fossil, which will be of great public utility in painting of ships, and in various manufactories. Dated March 22, 1810. Specification to be enrolled within two months.

MICHAEL SHANNON, of Berwick-street, in the county of Middlesex, Architect; for certain improvements in the art of brewing, which was communicated to him by a learned

a learned foreigner, since deceased. Dated March 22, 1810. Specification to be enrolled with two months.

JOHANN GEORGE DEYERLEIN, of Long-acre, in the county of Middlesex, Tool-maker; for certain inventions by himself, and communications made to him by a native of Germany, of a machine, new principle or method of making bricks and tiles; by means whereof, and of clay, loam, or similar materials to those commonly used in potteries, he is enabled to make all sorts of mouldings, beads, tubes, gutters, channels, or cylinders to convey water, smoke, or any fluid or soft substance. Dated March 22, 1810. Specification to be enrolled within six months.

JOHN GREGORY, of Islington, in the county of Middlesex, Builder; for a new method of tunning or cleansing ales and beers into casks. Dated March 22, 1810. Specification to be enrolled within two months.

FREDERICK KOENIG, of Camden Town, in the county of Middlesex, Printer; for a method of printing by means of machinery. Dated March 22, 1810. Specification to be enrolled within six months.

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ERRATA.

Page 273, line 30, *for* sulphate of potash *read* sulphite of potash; and on the same line, *for* this sulphate *read* this sulphite.

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END OF THE SIXTEENTH VOLUME.—SECOND SERIES.

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